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AMERICAN NATURALIST,

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OF

NATURAL HISTORY.

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SOME RECENT PAPERS ON EARTHWORMS.

BY J. S. KINGSLEY.

THE Oligochætous worms were long neglected, but within recent years the literature relating to them has extended to very considerable dimensions. It is the intention to present here an abstract of some of the work lately done on the group. The two papers[1] by Dr. Wilson on the embryology of these forms may be considered together. The forms studied are called *Lumbricus terrestris*, *L. communis*, and *L. fœtidus*.

The segmentation is unequal, but varies in its details in individual eggs of the same species. It results in the formation of a blastula, in which, at intervals, the blastocœl is in communication with the exterior by a cleavage pore. Some points of difference are shown between the species studied and that which formed the basis of Kleinenberg's classic paper.

Like Kleinenberg, Dr. Wilson finds that the "primary mesoblasts" are differentiated before gastrulation as two large cells lying side by side, at first on the surface but later sinking into the blastocœl. Before this insinking they begin to bud off the mesoderm in the shape of two parallel rows of cells. During this process gastrulation takes place. The egg becomes flattened, and a differentiation of the cells of the two sides occurs, the upper

[1] Wilson, Edmund B. The Germ-Bands of Lumbricus. *Journal of Morphology*, I., p. 183, 1 pl., 1887.

——The Embryology of the Earthworm; *l. c.*, III., p. 387, 7 pls., 1889 [1890].

(ectodermal) becoming flattened, while the entodermal are larger and more columnar. Next the sides of this placula-like structure are bent downwards, the approaching edges forming the slit-like blastopore, which closes behind, leaving the anterior end open as the mouth. In this operation the primary mesoblasts lie side by side at the posterior lip of the blastopore, the bands extending forward and eventually uniting in front of the mouth. During this process the ectoderm becomes thickened immediately over each band, but retains its character of a layer a single cell in thickness. At the same time, although the blastopore never closes, the inpushing of a stomodæum occurs.

The next feature of interest is the formation of the middle layer of the germ-bands, the existence of which was first distinctly recognized in the Oligochætes by Dr. Wilson. According to his account, this first appears as a linear arrangement of the ectoderm[2] cells, terminating behind in a larger cell. These terminal cells (which, like the primary mesoblasts, are called teloblasts) sink, together with the corresponding cell-rows, into a position between the ectoderm and the germ-band proceeding from the mesoblast. There may be either three or four of these rows on either side. The one towards the median line gives rise to the nervous system, the next two (nephric rows) to the nephridia and to the inner series of setigerous glands, while the outer (not constant) has a problematical fate. The corresponding teloblasts are called neuroblast, nephroblast, and lateral teloblast.

With the gradual elongation of the embryo these teloblasts continue to bud off new cells, which add to the corresponding row, which derive nothing from any other source. Behind, the rows are but a cell in width, but anteriorly they are wider, the two nephric rows becoming fused. Later the teloblasts disappear, and the bands of the opposite sides unite from before backwards. Certain cells budded from the rows wander between ectoderm and entoderm and form "migratory mesoderm," while the remainder, in which the cœlomic cavities appear, is the "trunk mesoderm." The former is mesenchymal in character, and gives rise to larval muscles, which are later replaced by true mesothelial muscles. The

[2] See below for Bergh's account, which differs considerably.

cœlomic cavities are schizocœlia, and are formed in the mesodermal bands behind the point of concrescence; the most anterior pair lie at the sides of the stomodæum, while a head cavity, which is always unpaired, occurs in front of the mouth.

The first blood vessel to appear is the subintestinal. It is at first without proper walls, and is apparently a remnant of the cleavage cavity. The dorsal vessel is at first double.[3] The two halves concresce from in front backwards.

Concerning the alimentary canal little need be said in this abstract. The stomodæum pushes inward as far as the sixth segment, and in one species its lips are at one time armed with a peculiar structure which may be either sensory or may serve as a larval digestive organ. As soon as the stomodæum is formed the larva begins to swallow the albumen with which it is surrounded and the particles of this are apparently swallowed amœba-like by the entoderm cells. The œsophagus with its calciferous glands is entodermal. The proctodæum is long delayed, and when it appears it is formed in the region where the primary mesoblasts break up; but our author was not able to decide whether in front or behind them, *i.e.*, within or without the limits of the blastopore.

The nervous system arises from the neural rows budded from the neuroblasts. The two most important statements made are: that the brain arises from these rows, and that it has a primitively paired condition and does not arise from a scheitelplatte. Dr. Wilson was unable to find any mittelstrang in the ventral cord. With growth the brain is carried backward from an extreme anterior position to the third somite, while by the same process the ganglia of the two anterior post-oral somites are pushed back upon that of the third to form the infraœsophageal ganglion. The giant fibres are apparently specially modified nerve fibres,—a view in conflict with Vejdovsky's account.

The origin of the excretory system as described by Wilson is quite different from the accounts of Bergh summarized farther on. First in the history comes the larval excretory organs or "schluckzellen," which are at first large ectoderm cells forming the anterior lip of the blastopore, and connected with a delicate system of

[3] This condition is permanent in many earthworms belonging to the family Perichætidæ.

ciliated canals lying between ectoderm and entoderm. They soon disappear. These were not carefully studied, nor were the pronephridia or head-kidneys. The permanent nephridia are regarded by Wilson as arising partly from the nephric rows, which are, as we have seen above, ectodermal in origin, and comparable in every early ontogenetic feature with the neural rows; the funnel is regarded as derived from the mesoderm proper. According to the account and figures, the nephric rows send upgrowths into every somite; these join a large cell on the anterior wall of each dissepiment. The large cell develops the funnel, while the cells of the nephric upgrowth becomes perforated to form the tubular portion of the nephridium. From each nephridial anlage a process is developed which becomes hollow, and the setæ of the inner row are developed in the cavities thus formed.

The speculations with which Wilson concludes his paper are of extreme interest, but as they deal with problems of general morphology they may be omitted here.

R. S. Bergh has also studied the development of the earthworm, with especial reference to the nervous system and Wilson's germ-bands. His account[4] differs in so many particulars that we cannot consider the fate of the germ-bands as settled.

Bergh paid no attention to the segmentation and gastrulation, but begins his account with the formation of the germ-bands. As his account of the fate of the different portions differs from Wilson's interpretation, he has applied different names to different portions, as is seen by this schedule:

WILSON.		BERGH.
Primary mesoblast	=	Posterior myoblast.
Neuroblast	=	Neuroblast.
Nephroblasts Lateral teloblast	=	Anterior myoblasts.

In the earliest stage studied by Bergh there is present on either side the posterior myoblast, the neuroblast, and a single

[4] Bergh, R. S. Neue Beiträge zur Embryologie der Anneliden. I. Zur Entwicklung und Differenzirung des Keimstreifens von Lumbricus. *Zeitschr. f. wiss. Zoologie*, Bd. L., p. 469, 3 pls., 1890.

one of the anterior myoblasts, each budding off its corresponding row. In next stage observed there were present two anterior myoblasts. The connection between these was not made out, but Bergh thinks from certain features that the new one was budded from the earlier one, and that the first to appear corresponds to Wilson's inner nephroblast, the second to his lateral teloblast. A later stage showed the budding off from the inner myoblast of the middle myoblast, and still later this was seen to form a row which becomes insinuated between the other rows. All of these cells are as yet ectodermal, and the neuroblasts and the neural rows are the first to become covered by the ectoderm. Apparently the bands are solely derived from the teloblasts, and the ectoderm contributes nothing further to this growth.

Bergh describes a new element in the nervous system as a plexus of nerve cells and nerve fibres, which develop along the middle of the ventral surface between the neural rows. In the ectoderm of this region, just beneath the ciliated line, are certain uni- and bipolar cells, the processes of which run lengthwise of the animal, and form a temporary nervous system before the permanent nervous system has begun the development of nerve fibres. These cells are regarded as arising independently of the neuroblasts from the ectoderm, the fact that they extend behind the neuroblasts being strongly confirmative of this view. Later this plexus is included in the permanent nervous system, while the ciliated cells are resorbed, and, contrary to Kleinenberg's view, do not form part of the regular ectoderm. Bergh suggests that the ventral median multipolar elements described by Friedländer may originate from this plexus. Hatschek's median invagination does not exist in Lumbricus.

The three remaining germ-bands, says Bergh, have nothing to do with the formation of the nephridia, and at no place do they project inwards, as described by Wilson, into the inner muscle plate. They rather spread out between ectoderm and the product of the hinder myoblast, and give rise to the circular muscles of the adult worm. These muscles are first formed ventrally, and later reach the dorsal surface.

The nephridia are, on the other hand, derived wholly from the inner mesoderm, the first portion to be distinguished being the

large funnel cells, which are recognizable before the formation of the cœlomic cavities. With the formation of the cœlom a row of cells buds off from the hinder surface of each dissepiment, just behind the funnel cell, to give origin to the tubular portion of the nephridium. The anterior myoblasts contribute nothing towards the formation of the nephridia, and these organs from the first have no structure uniting the successive somites. Bergh thinks that Wilson has misinterpreted his sections, and has missed some of the stages. The bristle sacs which Wilson thinks are derived from the germ-bands are, according to Bergh, formed as ingrowths from the ectoderm. With such differences of interpretation it, is difficult to say which is right. The work is in each case apparently thoroughly done, and a comparison of plates does not serve to reconcile the two accounts.

Benham's recent paper on the genera and species of earthworms[5] will prove of great value to students of the group, and an abstract is given here in the hope that it may aid American students of the group. The forms occurring in the United States are scarcely known. The Oligochætes are divided into:

Naidomorpha.

Small worms of relatively few somites; blood uncolored; male genital pores in, or in front of, somite VII.; asexual and sexual reproduction; eye spots frequently present; embraces the families Aphanoneura, Naidæ, Chætogastridæ, and the genus Ctenodrilus.

Lumbricomorpha.

Male genital pores behind somite VII.; reproduction only by sexual process; somites behind the peristomium all similar; no eye spots.

The characters separating the two divisions are not constant, except that which refers to the network of blood-vessels on the nephridia.

[5] Benham, W. B. An Attempt to Classify Earthworms. *Quarterly Jour. Micros. Sci.*, XXXI., p. 201, 1890.

MICRODRILI (Water Worms).

No capillary network of blood-vessels on nephridia; small size, thin, transparent body wall; setæ always in four groups per somite; prostomium not separated from peristomium by a groove. Contains families Discodrilidæ, Enchytræidæ, Phreoryctidæ, and Lumbriculidæ.

MEGADRILI (Earth Worms).

Large forms from one inch to six feet in length. Body wall thick and opaque; prostomium (when present) separated from peristomium by a groove; capillary network of blood-vessels on the nephridia; clitellum always occupying more than two somites. These are divided into PLECTONEPHRICA, with the nephridia in the form of delicate tubules in each somite, uniting to form a network, with more or less numerous external apertures; and MEGANEPHRICA, with the excretory network absent, replaced by a pair (rarely two pairs) of large nephridia in each somite. The members of each division are given below, the genera known to occur in the United States being given in italics.

PLECTONEPHRICA.

Family TYPHÆIDÆ; genera Typhæus, Megascolides, Cryptodrilus, Didymogaster, Perissogaster, Dichogaster, Digaster.

Family ACANTHODRILIDÆ; genera Acanthodrilus, Trigaster, Dinodrilus, Neodrilus, *Diplocardia*.

Family PERICHÆTIDÆ; genus Perichæta (including Megascolex).

MEGANEPHRICA.

Family MONILIGASTRIDÆ; genus Moniligaster.

Family EUDRILIDÆ; genera Eudrilus, Teleudrilus, Pontodrilus, Photodrilus, Microscolex, Rhododrilus, *Plutellus*, Stuhlmannia, Hyperiodrilus.

Family PERIONYCHIDÆ; genus Perionyx.

Family GEOSCOLECIDÆ; genera Geoscolex, Urochæta, Diacheta.

Family RHINODRILIDÆ; genera Rhinodrilus, Microchæta, Urobenus, Hormogaster, Brachydrilus.

Family LUMBRICIDÆ; genera *Lumbricus*, *Allolobophora*, Criodrilus, Allurus.

Besides the above, Benham includes four genera of uncertain position, viz., Helodrilus, Echinodrilus, Antæus, and *Eisenia*.

The genera of Megadrili recognized by Benham may be separated by the following key, modified only in method of arrangement from that given by him :

A, Setæ 16 to 80, or more, in a ring.
- *a*, Male pores far apart; small tufts of nephridia; — *Perichæta.*
- *aa*, Male pores very close together; large nephridia; — *Perionyx.*

AA, Twelve setæ on somite; clitellum on somites 14–16; — *Dinodrilus.*

AAA, Eight setæ on somite.
- *a*, Setæ alternate in consecutive somites throughout body; male pore on somite 22; — *Diachæta.*
- *aa*, Setæ alternate only posteriorly; male pore 20–21;[6] clitellum on somites 14–22; — *Urochæta.*
- *aaa*, Setæ in rows, not alternating.
  - *β*, Male pores 10–11, or 11–12; — *Moniligaster.*
  - *ββ*, Male pores on somite 13; — *Allurus.*
  - *βββ*, Male pores on somite 15.
    - *γ*, Prostomium dovetailed completely into peristomium; — *Lumbricus.*
    - *γγ*, Dovetailed incompletely; — *Allolobophora.*
    - *γγγ*, Not dovetailed; — *Criodrilus.*
  - *ββββ*, Male pores 15–16; — *Hormogaster.*
  - *βββββ*, Male pores on somite 17.
    - *γ*, Clitellum on somites 14–17.
      - *δ*, Setæ separate; — *Rhododrilus.*
      - *δδ*, Setæ in couples.
        - *ε*, One pair of sperm sacs; — *Typhæus.*

[6] Between somites 20 and 21.

εε, Two pairs of sperm sacs; *Digaster.*
γγ, Clitellum on somites 14–18; setæ in couples; *Eudrilus.*
γγγ, Clitellum on somites 13–17; lobed prostates, one pair; *Microscolex.*
γγγγ, Clitellum on somites 13–20; prostates tubular, two pairs; *Dichogaster.*
ββββββ, Male pores on somite 18.
γ, Two pairs of prostates on somites 17–19.
δ, Male pores in a deep fossa; *Trigaster.*
δδ, Male pores not in a fossa; *Acanthodrilus.*
γγ, One pair of prostates on somite 18.
δ, Clitellum on somites 13–17.
ε, Prostomium dovetailed.
ζ, Prostate convoluted; *Pontodrilus.*
ζζ, Prostate lobate; *Cryptodrilus.*
εε, Prostomium not dovetailed; *Photodrilus.*
δδ, Clitellum on somites (13) 14–17; prostomium dovetailed; setæ separate; *Plutellus.*
δδδ, Clitellum on somites 14–18.
ε, Setæ equidistant; *Didymogaster.*
εε, Setæ in couples; *Perissogaster.*
δδδδ, Clitellum on somites 13–21 or more; *Megascolides.*
γγγ, No prostates; clitellum on somites 16–21; *Brachydrilus.*
βββββββ, Male pores 18–19.
γ, Prostomium broad; setæ simple; clitellum 15–23. *Geoscolex.*
γγ, Prostomium elongate; setæ ornamented; clitellum 15–25; *Rhinodrilus.*
βββββββββ, Male pores on somite 19.
γ, Clitellum 10–25; *Microchæta.*

γγ, Clitellum 14–17; *Teleudrilus.*

ββββββββ, Male pores on somite 20;
clitellum 14–25; *Urobenus.*

In explanation of the above key it may be said that the peristomium is regarded as the first segment. The prostomium is sometimes separated from the first somite by a transverse groove; but frequently grooves start on the prostomium and extend back into the first somite, so that the prostomium appears "dovetailed" with the peristomium. If the grooves stop after traversing the first somite for a short distance, the prostomium is partially dovetailed. The external openings of the sperm ducts are the male pores. The term sperm sacs is applied to the vesiculæ seminales, the testes of the older authors; the prostates are diverticula of the sperm ducts near their external opening.

There are several genera which are not included in the above summary. Thus Garman has described[7] a genus Diplocardia, from Illinois, which belongs to the family Acanthodrilidæ, but differs from Acanthodrilus in having the dorsal vessel paired throughout its entire length, and in the absence of a subneural blood-vessel. It agrees with Dinodrilus in the double dorsal vessel, but differs in having but eight setæ. Garman also mentions the existence of Perichæta in Champaign, Ill. A species, apparently of the same genus, occurs in Lafayette, Indiana, where it caused the students no little trouble to make it fit the description of Lumbricus given in Brooks's Zoology.

A paper by Michaelsen[8] has not been seen. It describes several African forms of the family Eudrilidæ, among them a genus Stuhlmannia. Allied to is another African genus lately described by F. E. Beddard.[9] It is called Hyperiodrilus, and presents many interesting peculiarities of reproductive organs.

[7] Garman, H. On the Anatomy and Histology of a New Earthworm (*Diplocardia communis*). Bulletin Illinois State Laboratory of Natural History, III., pp. 47, 5 plates.

[8] Jahrbuch der Hamburg wissinsch. Anstalten, Bd. VII.

[9] Beddard, F. E. Preliminary Note on a New Earthworm Belonging to the Family Eudrilidæ. *Zool. Anzeiger*, XII., 1890.

The genus Deodrilus[10] proposed by Mr. Beddard has its sole representative in Ceylon. It seems to combine the character of several of Benham's families, and its exact position is uncertain. Beddard regards it as nearest Typhæus and the Geoscolicidæ, with some affinities with Pontodrilus and many Eudrilidæ. Beddard announces a forthcoming classification of the earthworms.

In the same paper he describes a connection of the nephridia with the terminal region of the intestine as occurring in the New Zealand species *Acanthodrilus multiporus*. These nephridia are connected with the general nephridial network found in the Plectonephrica. Whether the portion of the intestine with which they are connected is proctodeal or entodermic is unsettled. Beddard makes some interesting comparisons with the respiratory trees of the *Gephyrea chætifera*, and also with the malpighian tubes of the Hexapods.

THE MECHANICAL ORIGIN OF STRUCTURE IN PELECYPODS.

BY ROBERT TRACY JACKSON.

IT is desired in this paper on Pelecypods to call attention to some cases recently studied in which the structure of the animal seems to be the direct consequence of the physiological reaction induced by the mechanical requirements of the environment; or to cases of "mechanical genesis," as they have been termed.[1] Several of our examples are cases in which similar forms are built up on similar lines of development, but in widely separated or totally distinct groups of animals. They therefore afford evidence

[10] On the Structure of a New Genus of Oligochæta (Deodrilus); and On the Presence of Anal Nephridia in Acanthodrilus. *Quart. Jour. Mic. Sci.*, XXXI., p. 467, 2 pls., 1890.

[1] This paper is taken largely from a recently published memoir, to which the reader is referred for a fuller discussion of many facts presented. See Phylogeny of the Pelecypoda, the Aviculidæ and Their Allies; by Robert Tracy Jackson. Mem. Bost. Soc. Nat. Hist., Vol. IV., No. 8, July, 1890, pp. 277-400, pls. XXIII.-XXX.

in favor of definite lines of variation, and in so far support the view that acquired characters are inherited.

Mr. Wm. H. Dall, in a recent highly interesting paper on Pelecypods, explains the form and progressive development of the ligament, cartilage pit, and teeth of that group as the result of the mechanical strains and stresses to which the parts are exposed.[2]

In the development of Pelecypods we find in a late embryonic stage (the phylembryonic) that the shell has a straight hinge line. This is characteristic of Ostrea (Fig. 1), Cardium, Anodonta, and so many widely separated genera that it apparently represents a primitive ancestral condition common to the whole class. Embryology shows that the bivalve shell doubtless arose from the splitting on the median line of a primitive univalvular ancestor. If that ancestor had a saddle-shaped[3] or a cup-shaped[4] shell, as is probable, the first result of the introduction of a hinge in the median line would have been to straighten the shell on the hinge line. This is a simple problem in mechanics, for if one tries to break by flexion a piece of metal which is saddle-shaped or cup-shaped, it will tend to form a straight line on the axis of flexion. A parallel case is seen in the development of a bivalve shell in ancient crustaceans. The ancient Ostracoda: Leperditia, Aristozoe, etc., have a straight hinge line and subcircular valves, which are united dorsally by a ligament. The resulting form of the early condition of the bivalvular shell in these two distinct classes is so strikingly similar, it lends weight to our supposition that the form is induced by the mechanical conditions of the case.

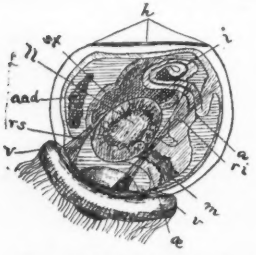

FIG. 1.—*Ostrea edulis*, embryo; *a ad*, anterior adductor muscle; *m*, mouth; *a*, anus; *v*, velum; *h*, hinge of shell; (after Huxley).

I think that the adductor muscles which close the valves may also be demonstrated to be the necessary consequence of the bivalvular condition. In the phylembryo stage (Fig. 1) the valves are closed by a single adductor muscle, which is the sim-

[2] On the Hinge of Pelecypods and Its Development, with an Attempt Toward a Better Subdivision of the Group; by Wm. H. Dall. *Am. Jour. Sci.*, Vol. XXXVIII., Dec.,

plest condition mechanically possible to effect the desired end.[5] This muscle does not seem to be homologous with any muscle in other classes of molluscs, and is probably developed from the mantle muscles as a consequence of the conditions of the case. In support of this view bivalvular crustaceans may again be cited. They have an analogous adductor muscle, developed of course on an entirely different line of descent, but under closely similar mechanical conditions. At the completed prodissoconch stage in all Pelecypods, as far as known, there are two adductor muscles, a second one having developed in the posterior portion of the body. In later life the anterior, the posterior, or both adductors may be retained, reduced, or lost, according as the persistence or changes in correlated anatomical features retain in use or bring into disuse the muscles in question.

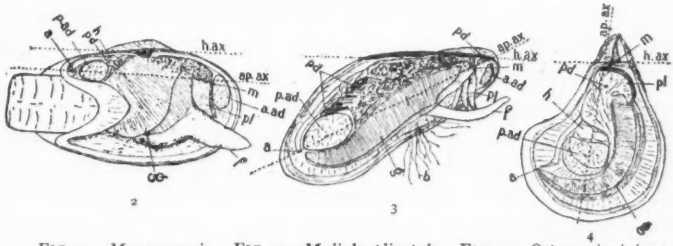

FIG. 2.—*Mya arenaria.* FIG. 3.—*Modiola plicatula.* FIG. 4.—*Ostrea virginiana,* Lettering: *ap ax*, antero-posterior axis; *h ax*, hinge axis; *a ad*, anterior, and *p ad*, posterior adductor muscle; *m*, mouth; *pl*, palps; *a*, anus; *g*, gills; *pd*, pedal muscle; *f*, foot; *b*, byssus; *h*, heart.

Let us look at examples of the retention or loss of the adductors. In typical dimyarian Pelecypods, as Mya (Fig. 2) or Venus, the adductors lie toward either end of the longer axis of the shell. As the hinge occupies a position on the borders of the shell about midway between the adductors, both muscles are nearly or quite in a position to be equally functional in closing the valves. As

1889. The same author explains graphically on a mechanical ground the origin of structures in Gastropods. See pp. 58–65, Trans. Wagner Free Institute, Vol. III., Aug., 1890.

[3] Characteristic of young Dentalium.

[4] Characteristic of the extreme young of cephalous molluscs.

[5] This early adductor appears in the same position in many genera, and is apparently characteristic of the class. It is the anterior of the two adductors found in later stages; but it may be retained or lost in the adult.

a result, both muscles are of about the same size. The condition described is that existent in the completed prodissoconch stage in all Pelecypods, as far as known. In later life, however, a revolution of the axes of the soft parts may take place, so that the antero-posterior axis (represented by a line drawn through the mouth and middle of the posterior adductor muscle), instead of being parallel to the hinge axis (the axis of motion of the valves) as in dimyarians, may present a greater or less degree of divergence from the parallel. In progressive series, as in Modiola (Fig. 3), Perna, etc., as the anterior adductor is brought nearer and nearer to the hinge line, where its mechanical action is less and less effectual in closing the valves, we find that it is more and more reduced until it finally disappears from disuse and atrophy, as in Ostrea (Fig. 4), and Pecten. Conversely, the posterior adductor in the same series in the revolution of the axes is pushed farther and farther from the hinge line and nearer to the central plane of the valves, where its mechanical action is most effectual in closing the valves. With its increase in functional activity the muscle increases in size. The revolved position of the axes, and the consequent reduction or loss of the anterior adductor and increase of the posterior adductor, is found in many widely separated genera of Pelecypods, as Ostrea, Mulleria and Tridacna; thus proving the development of the same features on different lines of descent.[6] In Aspergillum the two valves have concresced so as to form a truly univalvular, tubular shell, so that the adductors would evidently be functionless if existent. The posterior adductor has disappeared and the anterior is reduced to a few disconnected shreds (Fischer), though evidently existent in the young, as attested by the form of the shell in the nepionic stage.

The condition of the foot in Pelecypods depends largely upon its use or disuse. In free-crawling or burrowing forms the foot is highly developed, and is sometimes of a peculiar form which could doubtless be traced to special functional uses. In Pecten, in the nepionic period, the foot is highly developed, and actively

[6] Dr. B. Sharp and I published almost simultaneously closely similar views on the mechanical aspect of the relative size of the adductors. See Proc. Acad. Nat. Sci. Phila., 1888, p. 122, and Proc. Bost. Soc. Nat. Hist., Vol. XXIII., 1888, p. 538.

employed in crawling. In later stages the animal adopts the habit of byssal fixation, and then of free swimming. The foot becomes highly reduced, and in the adult is probably a functionless organ. In shells which are permanently attached by calcareous fixation the foot is highly reduced or absent, as in Chama, Spondylus, and Ostrea (Fig. 4). In Ostrea the shell becomes permanently attached at the close of the free-swimming veliger stage; therefore the foot is unnecessary before fixation and useless afterwards, and it has almost entirely disappeared from even embryonic stages of growth. In *Anomia glabra* the foot is active and well developed in nepionic stages; but later, as the animal becomes permanently attached, it is reduced, and in the adult is highly atrophied.

Ordinarily there are two posterior retractor muscles of the foot in Pelecypods, one situated on either side. In adult Pecten either the left retractor alone exists, or both retractors are wanting (the left doubtless always exists in the young). In studies of young *Pecten irradians* I found that the animal always crawled while lying on the right side, with the foot extended through the notch in the lower valve and pressed against the surface of support. It is evident that while crawling in this position the left retractor is in the plane of traction, and it is retained; on the other hand, the right retractor would not be in the plane of traction, and it has disappeared through disuse and atrophy.[7] A similar disappearance of the right retractors of the foot is seen in *Anomia glabra*, and is explained on similar bases of argument.

The action of the foot in its effect on the form of the shell in some cases presents interesting mechanical features. In dimyarian Pelecypods which crawl freely the foot protrudes from an area on the free border of the valves, nearly opposite to and comparatively far removed from the hinge line. In such cases, by a slight gaping of the valves, a considerable opening is made, through which the foot extends without (ordinarily) the aid of any special notch. On the other hand, in monomyarian Pelecypods, where the revolved position of the axes brings the foot close up to the hinge line, a special notch is required for the extrusion of the foot, as the valves would have to gape very widely to permit of its

[7] Both retractors probably exist in the prodissoconch stage of Pecten and allies.

passage at that area. Such a notch we find in Tridacna, Pecten, and many allies. Young *Pecten irradians* crawls while lying on its right valve by extending the foot over the edge of the valve. The constant extension of the foot would necessarily cause a local retraction of the right mantle lobe at that area; therefore shell growth would proceed less rapidly, and a notch would consequently be formed. By this action no pressure is exerted on the left mantle lobe, and no notch is formed on that side of the shell.[8] In later life the crawling habit is abandoned, the foot atrophied, and the notch nearly or quite disappears, as I have observed in several species of Pecten. The presence of a byssus at such an area may induce a notch, as well as the crawling habit, as may be observed in Avicula and Meleagrina. Young Hinnites and Spondylus are pecteniform and have a deep byssal notch, as I have shown;[9] but as soon as they become attached by cementation to a foreign object the use of the foot is of course abandoned, and the notch is not perpetuated in succeeding shell growth. In the development of Anomia we find that the right valve surrounds the byssus completely, enclosing it at an early stage. In later growth the byssus and calcareous byssal plug become greatly enlarged, the walls of the enclosing foramen receding to give space for the enlargement of the organ. This enlargement of the foramen is apparently to be explained on the physiological principle that constant pressure causes a resorption of tissue.

In free-crawling or superficially burrowing Pelecypods the foot is extended from an area nearly opposite the hinge line, that being the most effectual position for crawling while the valves are in an upright position. In deep-burrowing forms, as Solen, on the other hand, the foot is extended at an area nearer the hinge line and in the plane of the longer axis of the shell. It is evident that in this position it is more effectual in producing a hole, it is in a better position to drag the shell after it, and it offers the least resistance to the surrounding medium. In deep burrowers, as *Mya arenaria*, and especially *Ensatella* (*Solen*) *americana*, it is to

[8] For figures illustrating this stage see this journal, December number, page 1138 Figs. 11, 12.

[9] Phylogeny of the Pelecypoda.

be observed that the borders of the shell gape at either end. This is evidently caused by the constant extension of the foot and siphons, which, pressing on the mantle border, thus keep it back at those areas and modify the direction of shell deposition. Another active cause for the gaping of the valves is doubtless the loss of the habit of withdrawing the organs and closing the valves as a source of protection. Such forms as we are considering are protected in a measure by the surrounding sand or other medium, and in time of danger seek safety by burrowing deeply.

In *Mya arenaria* we find a highly elongated siphon. In the young the siphon hardly extends beyond the borders of the valves, and then the animal lives at or close to the surface. In progressive growth, as the animal burrows deeper, the siphon elongates, until it attains a length many times the total length of the valves. The ontogeny of the individual and the paleontology of the family both show that Mya came from a form with a very abbreviated siphon, and it seems evident that the long siphon of this genus was brought about by the effort to reach the surface, induced by the habit of deep burial.

In the structure of *Pecten irradians* we find the most complete adaptation to the mechanical requirements of the act of swimming. Pecten swims by the rapid opening and closing of the valves, with the resultant violent expulsion of water; but the details of the method are somewhat intricate. In swimming, as well as when at rest, the left valve is always uppermost, and the plane of the edges of the valves is inclined to the surface of the water at an angle of about 45°. The mantle folds are built up in perpendicular walls on the periphery, and these walls perform an important function in swimming. Lying on the bottom, the Pecten suddenly closes its valves by the quick action of the adductor muscle. The first water expelled is driven out posteriorly in the direction of the arrow *a*, Fig. 5, and if this were the only or the main direction in which a current is expelled, the animal would by impact of water be driven in the opposite direction, or anteriorly, which is not the case. When the valves have closed to a slight extent, the borders of the two thick perpendicular mantle walls come in contact, and then no more water is

driven out posteriorly; but instead, during further closure of the valves it is ejected from the lower border of one ear, where the mantle wall is low and thin, in the direction of the arrow *b*. The water expelled at this area is the most forcible current, and is probably of the greatest volume, as by its means the animal is impelled in the opposite direction, as indicated by the arrow *c*. The valves open quickly and clap again. The second time as before the first water is driven out posteriorly; but when the mantle walls come in contact the direction of the excurrent is again changed and it is forced out from the lower border of one ear in the direction of the arrow *d*. Being the strongest current, it impels the animal in the direction of the arrow *e*. At successive claps the water is driven out from alternate ears, as shown in the figure. The resultant action of the several currents and successive claps is to drive the animal in the direction of the free borders of the valves, or posteriorly. It is due to the alternate expulsion of water from either ear, as shown in the figure, that the animal presents a series of zigzag jerks in swimming. The action of the first current expelled posteriorly, before the mantle walls come in contact, gives the animal an upward jerk, and it is in virtue of this jerk, combined with the momentum in a posterior direction, that it maintains its position on the surface of the water, and also the high angle to the surface which it presents in swimming. This current is so powerful that by its action water may be squirted by adults to the height of five inches or more from the surface. In the shell a correlated feature of the swimming habit is seen in the incomplete closure of the valves at the eared areas. Water may therefore pass out when the free borders of the valves are in immediate contact, as they are at each clap, as indicated by the sharp clicking noise made in swimming.

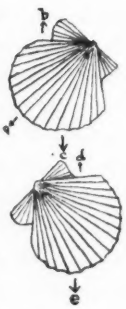

FIG. 5.

The tendency to equalize the form by growth in a horizontal plane in relation to the force of gravity acting in a perpendicular plane, or the geomalic tendency of Professor Hyatt,[10] is seen mark-

[10] Transformations of Planorbis at Steinheim, with Remarks on the Effects of Gravity upon the Forms of Shells and Animals. Proc. Am. Ass. Adv. Sci., Vol. XXIX., 1880.

edly in Pelecypods. In forms which crawl on the free borders of the valves the right and left growth in relation to the perpendicular is obvious, and agrees with the right and left sides of the animal. In Pecten the animal at rest lies on the right valve, and swims with the right valve lowermost. Here equalization to the right and left of the perpendicular line passing through the centre of gravity is noticeable (especially in the Vola division of the group); but the induced right and left aspect corresponds to the dorsal and ventral sides of the animal,—not the right and left sides, as in the former case. Lima, a near ally of Pecten, apparently swims with the edges of the valves perpendicular. In this case the geomalic growth corresponds to the right and left sides of the animal.

The oyster has a deep or spoon-shaped attached valve and a flat or flatter free valve. This form, or a modification of it, we find to be characteristic of all Pelecypods which are attached to a foreign object of support by the cementation of one valve. All are highly modified, and are strikingly different from the normal form seen in locomotive types of the group. The oyster may be taken as the type of the form adopted by attached Pelecypods. The two valves are unequal, the attached valve being concave, the free valve flat; but they are not only unequal, they are often very dissimilar,—as different as if they belonged to distinct species in what would be considered typical forms. This is remarkable as a case of inherited or acquired characteristics finding very different expression in the two valves of a group belonging to a class typically equivalvular. The attached valve is the most highly modified, and the free valve is least modified, retaining more fully ancestral characters. Therefore it is to the free young before fixation takes place, and to the free, least-modified valve, that we must turn in tracing genetic relations of attached groups. Another characteristic of attached Pelecypods is camerated structure, which is most frequent and extensive in the thick attached valve. The form as above described is characteristic of the Ostreidæ, Hinnites, Spondylus, and Plicatula, Dimya, Pernostrea, Ætheria, and Mulleria, Chama and its near allies. These various genera, though ostreiform in the adult, are equivalvular and

of totally distinct form in the free young. The several types cited are from widely separate families of Pelecypods, yet all under the same given conditions, adopt a closely similar form, which is strong proof that common forces acting on all alike have induced the resulting form. What the forces are that have induced this form it is not easy to see from the study of this form alone; but the ostrean form is the base of a series, from the summit of which we get a clearer view.

As I stated in an earlier paper,[11] the fullest modification in the ostrean line of variation is the production of a shell in which the attached valve is cup-shaped, conical, or subcylindrical, as seen markedly in species of the Chamidæ and Rudistæ. In this group as a whole, and in progressive stages of growth of its extremest members, all steps may be followed between a simple ostreiform or exogyriform shell and the most highly modified conical type. The Ostrea form is the first step in this line of modification, the Exogyra form is the second step, and the conical form is the last step. What are the mechanical causes which bring about this resultant form? I suggest as an hypothesis the following: The Rudistæ are conical or cup-shaped Pelecypods, with a superficially marked radial symmetry. So striking is the radial feature that they have been classed with the corals or Cirripeds, and the term radial is combined frequently in generic and specific names of the group. *Barretia monolifera*, as described by Woodward, is highly radial, and the infoldings of its thin walls closely resemble the radial septa of corals. In other animals which are permanently attached by calcareous fixation, as corals, some worms and Brachiopods, Cirripeds, and others, we find closely comparable forms which are subcylindrical or subconical, with a very marked degree of radial symmetry. Finding so many similar forms built up on different lines of descent affords strong evidence that common forces acting on all alike have induced the resulting form. The equal impact of moving water on all sides of an attached, growing organism, it seems, would cause an equal effort of resistance on all sides, and therefore induce an equal growth on all sides, thus producing a form

[11] Studies of Pelecypoda, AMER. NAT., Dec. 1890, p. 1135.

circular in section at any one horizon, and subconical, cup-shaped, or globose in its entirety, as are the forms which we are here considering. To strengthen the walls of a round organism we might have solid accumulation, vesicular accumulation, or perpendicular partitions arranged at right angles to the supported wall. Such mechanical supports are characteristic of attached Rudistæ and other Pelecypods, Cœlenterates, Cirripeds, and some worms. As all sides of the periphery of an attached organism are equally exposed to food supply, danger, etc., the organs, as tentacles, nerve centres, and eyes would gradually tend to become situated at all points on the periphery, or radially. It is well known that the external parts of an animal are more easily modified than the deeper-seated parts. It is also known that the modification of deeper-seated parts may be progressively produced from without inward, or centripetally. If we have an attached animal that is round, with some organs arranged on the periphery, a common case, then further modification or development of such organs or parts would tend to be produced centripetally, or radially, for the centripetal variation of a round form would, as a mechanical necessity, be radial variation. In the Hydrozoa there is a strong proof of the correctness of this view. Passing from Protohydra to Hydra, to the hydroid stage of Aurelia, then to the free medusoid stage of Aurelia and other Discophores, we find progressively a more and more perfect radial symmetry built up centripetally. A similar comparison may be made in the development of corals.

Many permanently attached forms of bilateral classes of animals assume a considerable degree of radial symmetry; and, conversely, many free locomotive forms of radiated classes assume a considerable degree of bilateral symmetry. As bilaterality is a feature induced and progressively built up by the conditions of free locomotion, it is believed that radiality is induced and progressively built up by the conditions of permanent fixation, with its attendant influences of environment.[12]

[12] Since this paper was in type my attention has been called to the fact that Haeckel, in his Gastræatheorie, considers the sedentary life of ancestral forms of the zoöphytes as the mechanical efficient cause of their radial symmetry.

SEXUAL IMMOBILITY AS A CAUSE OF THE DEVELOPMENT OF THE SPOROPHYTE.

BY CONWAY MACMILLAN.

IN the *Annals of Botany*, August, 1890, are to be found two very interesting papers on the alternation of generations in plants. One is by Professor F. O. Bowers, who defends Alakovsky's distinction between antithetic and homologous alternation; the other by the late J. Reynolds Vaizey, who shows the impossibility of establishing homologies between sporophores and oöphores. Each of these papers presents somewhat more clearly than usual the problems which underlie all attempts at a general coördination of vascular plants, mosses, and the lower algæ, and in each of them there is some effort to account for the origin of the phenomenon of alternation itself. Bowers is inclined to ascribe entirely different causes to the sporophyte of the Archegoniatæ and the so-called sporophytic plants of Vaucheria, Mucor, or Œdogonium. These latter he conceives to be modified oöphytes,—or gametophytes, to use his terminology,—while the former is an interpolated plant, altogether devoid of homologies with the gametophyte of its own species or that of any other. To the sporophyte of the Archegoniatæ he ascribes change of habit from aqueous to subaërial nutritive media as the producing cause, and proceeds to adduce morphological and phylogenetical evidence in support of the position. The purpose of this brief note is to indicate an opinion of the writer that something quite different, and not altogether overlooked by Bowers, is possibly the sufficient cause for the development of sporophytes, not only in the Archegoniatæ, but wherever sporophytes are developed at all.

In the first place, it should not be overlooked that in animals higher than the Medusæ and Flat Worms (with rare exceptions, *e.g.*, Salpa?)[1] there is nothing comparable with the alternation of

[1] The alternation in plant-lice (Aphidæ) is a different matter entirely, and need not be considered here.

generations—that rhythmic succession of sexual and asexual individuals—which continues with perfect distinctness even into the order Compositæ,—according to Luerssen, the highest family of plants. Why, now, there should be such a rhythm in plants and not in animals is a point to be explained, and very likely the explanation will throw light upon the origin and perpetuation of alternation in the vegetable kingdom. It is of no use to say, as Geddes does, quoted by Bowers, that alternation is "a rhythm between relatively anabolic and katabolic preponderance." For why should such rhythm exist in plants and not in animals? In fine, there seems to be but one explanation readily entertained, and that is this: *Alternation of generations is a phenomenon conditioned upon individual immobility.* It is readily discovered that in almost every species of animal free to move where it pleases alternation is not seen, while in many of the somewhat fixed and immobile alternation is apparent,—for example, in the Cœlenterates. And in the more mobile plants alternation is either indistinct (homologous) or scarcely apparent, while in the more immobile plants alternation becomes exceedingly distinct, and reaches its highest type in in the most immobile plants. Now the sexual act, being conditioned upon the approach to each other of the gametangia or gametes themselves, is accomplished with greater and greater difficulty the more complete the immobility of the sexual individual. In animals immobility is at its maximum; in the higher plants—notably most Angiosperms—it is at its minimum. In other words, the sexual act is easiest of accomplishment in animals, speaking generally, and most difficult in the higher plants; consequently the egg, in animals, is easily produced, but in a plant of the Archegoniate series an egg is produced with great difficulty. In spite of the high gonotropic specializations in other plants, probably not a millionth part of the sexual individuals produced ever accomplish their end. For this reason the egg of an animal is, on the whole, a *cheap* product; the egg of an Archegoniate plant is an *expensive* product.

From the considerations outlined above we have no difficulty in perceiving the physiological conditions which lead to the appear-

ance and to the great development of the sporophyte. In Œdogonium the egg divided into four swarm-spores. For one sexual act four plants may be obtained. In Chara the number of spores produced directly from the egg is still greater, and the carpogone wall becomes thickened and specialized as a covering to protect the result of the sexual act. In Riccia the egg itself develops an epidermal layer, besides the spore-mother-cells within. As the number of these spores becomes greater a columella is required to strengthen the capsule; it appears in the Anthocerotæ. To scatter the spores better the capsule is elevated on a stalk in the Jungermanniæ. To the same end elaters are developed in the Hepaticæ (and later in the Equisetaceæ). The stalk of the capsule becomes longer and the whole sporophyte more complex in the Musci. In the ferns, leaves and roots are assumed by the sporophyte, in order that (having access to more nutriment) it may produce more spores. Throughout the whole upward series of developing, specializing, progressing sporophytes we see one distinct end in view, viz., the making of an egg, when fertilized, go as far as possible.

Now whether there is any difference between the sporophyte developed, under these conditions, in an aquatic plant like Chara or Coleochæte, and the sporophyte developed under exactly similar conditions in an amphibious plant like Ophioglossum, I cannot say. Certainly in either case the meaning of the sporophyte remains the same. It is, wherever we meet it, whether in Chara or in Juglans, in Œdogonium or Taxus, a device for making the most out of that sexual act accomplished with so much difficulty, and with the chances so tremendously against successful consummation.

If the correct explanation of the origin of sporophytes is given above, it is difficult to see why a sporophyte should not in every case be considered an "interpolation" between successive gametophytes. Wherever met, the sporophyte is simply more or less elaborate subdivision of the fertilized egg. In Œdogonium it is a direct subdivision; in Helianthus it is an indirect subdivision. Properly speaking, the gametophyte is the *plant;* the sporophyte

PLATE I.

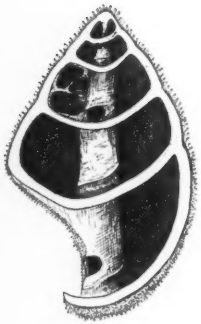

FIG. 1.

FIG. 2.

FIG. 3.

FIG. 4.

FIG. 5.

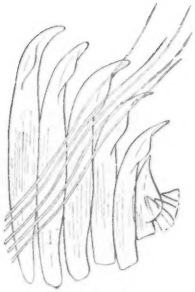

FIG. 6.

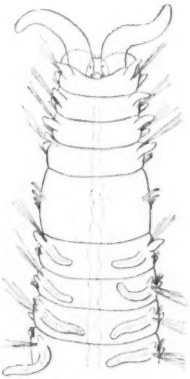

FIG. 7.

Polydora commensalis.

is, at its greatest development, nothing more than a highly complicated, self-supporting *pod*.

The sporophyte, then, may be considered in its widest sense as *a result of vegetative reproduction applied to the fertilized egg*. As the thallus of Marchantia is cut into gemmæ, so the egg of Marchantia may be cut into the cells of the sporophyte. The strict analogy of sporophytes is, I suppose, not questioned. The question as to their homology must be studied from the physiological point of view, as well as through the researches of anatomists and embryologists. Without either dissenting from or endorsing the view of Bowers, the writer has tried only to show that emphasis may be laid upon conditions surrounding the sexual act as a help to a clearer comprehension of the phenomena of alternation.

A COMMENSAL ANNELID.

BY E. A. ANDREWS, PH.D.

CASES in which Annelids are believed to live more or less directly dependent upon other Annelids, upon Crustacea, Gasteropods, Echinoderms, and even upon Cœlenterates, are not unknown, but yet form by far the exception rather than the rule in the economy of this group. Of the reported cases some must be regarded as mere temporary refuge of Annelids in cavities offered by the shells or bodies of other creatures; some are such mechanical associations as are presented in the complicated assemblage of various Annelid tubes in sponges or molluscan shells, etc.; while yet others—and these are few—are illustrations of true commensalism, which may pass over into parasitism, as in the Oliognathus living in Bonellia, the Hæmatocleptes living within another Annelid, or the well-known Alciope living inside Ctenophores.

In 1885 Dr. Brooks called my attention to a very interesting case of commensalism involving an Annelid found at Beaufort, N. C., and which is complicated by the fact that three diverse

animals—Annelid, Crustacean, and Hydroid—are here concerned, forming, as it were, a triple alliance, in which each is, moreover, dependent upon the shell of a fourth, a Gastropod.

Over the immense sand-flats of "Bird Shoal" the interdependence of various creatures is especially well illustrated, and this seems in part due to the fact that the entire absence of stones and rocks leads to the burdening of the more securely fixed animals and plants by those less able to resist the changing tides, waves, and moving sand. Thus we find the stout tubes of the Annelid, Diopatra, which project several inches from the sand, seized upon by Algæ, Hydroids, Molluscs, Annelids, and especially by large Ascidians, as the only available, somewhat stable foundation to build upon. Here also occurs in great abundance the small hermit crab (*Eupagurus longicarpus*), inhabiting the empty shells of various small Molluscs, especially the most accessible one,—that of the Gasteropod, *Ilyanassa obsoleta*. Quite a large proportion of the shells so inhabited are covered over almost completely by colonies of the interesting Hydroid, Hydractinia, though the constant moving about of the crab keeps a small circular area of the shell free from this growth, owing to the friction of the shell against the sand as it is dragged along. Undoubtedly the Hydractinian is benefited by this association, since it may obtain some of the food not used by the crab, and since it is upon a surface kept by the crab above the bottom, and protected from the constant danger of permanent burial in the sand. If, on the other hand, the crab, as seems probable enough, is protected by the presence of so well-armed a creature as the Hydroid, we would have here a cause of "mutualism." With this combination of Hydroid and crab is also associated a commensal,—a small Annelid of the family Spionidæ and genus Polydora. Of several hundred shells examined, fifty per cent. were inhabited by this Polydora, in addition to the crab. In those without Hydroids the Annelid is less abundant, but such shells are often very old or broken, or else but temporarily used by the crab. Occasionally an empty shall contains an Annelid; but here we may assume that a crab has recently occupied it and only been out for a short time, since the majority of available shells are either taken pos-

session of by the hermit or else became buried or washed away. In no case could an Annelid be found in a shell containing the original proprietor,—the Ilyanassa.

A somewhat similar case of an Annelid occurring in the dwelling of a hermit crab was long ago noticed by Quatrefages, but there the Annelid, a Nereis, may possibly have taken up only temporary quarters within the shell. This, however, seems not to be the case with the Nereis described by Wirén in 1888, which, it would appear, has been modified by its well-acquired habit of living inside such shells. The Polydora, however, does not merely live within the pre-formed cavity of the Gasteropod shell, as the Nereis would, but, by boring a tunnel in the columella, and by partly filling up some of the spiral cavity of the shell with a calcareous tube of its own manufacture, reconstructs the shell to fit its own needs.

The general character of the dwelling made by the Annelid within the Gasteropod shell may be inferred from a view of the shell cut lengthwise into halves, as in Fig. 1. The external opening of the tunnel is seen on the inner lip of the mouth of the shell as a conspicuous rounded hole, which leads by a long passage inside the columella up to the spiral part of the shell. Here the tunnel opens out again into the apical chamber of the shell by the round hole seen in the figure. The inner opening, however, is continuous with a calcareous tube built into the chamber of the shell in such a way as to completely block it and prevent the posterior end of the crab, or any other object, from pressing up into the smallest terminal spirals. This tube is bent or coiled in various ways, but may present, as in the figure, a cross-section suggesting that of a Mammalian cochlea. Made of a calcareous, cement-like mass, it may be the debris of the bored-out tunnel, but is more probably a special calcareous secretion of the Annelid such as some of its relatives are known to make.

This description applies only to certain cases, since many irregularities are observed both in the calcareous tube and in the tunnel, and some shells present external openings near the apex and apparently communicating with the Annelid's dwelling.

Only one adult Annelid is found in each shell, and this may be

seen, in part, even without destroying the shell, since, when the crab is not too active, the anterior part of the Polydora may protrude from the external opening in the columella, reach about in the water, and presumably find and swallow food in the sand or currents of water. Yet it is very easily disturbed, and then to be found only within the columella, or even in the upper calcareous tube, where it may be variously coiled about, since the dwelling is everywhere wide enough for the Annelid to bend back and forth upon itself. The part of the old shell utilized by the Annelid is thus intermediate between that the crab occupies and that covered over by the Hydroid. The former, in drawing in and out of the shell, tends to limit the excursions of the Annelid by dragging its claws over the columella and orifice of the Annelid's tunnel; the latter extends up to the very edge of the Annelid's place of exit. Sometimes the Annelid's tunnel appears to have been cut through into the chamber occupied by the hermit, but then covered in again by a calcareous layer protecting the Annelid from contact with the crab.

Considering how impossible it would be for the Annelid to keep the shell free from sand and prevent its burial, it is obvious that this Polydora, if it lives, as it appears to, only in such a commensal state, is dependent upon the habit of the hermit crab, and thus exists in what is a somewhat recently acquired environment. As, however, other species of Polydora are known to make tunnels into various Gasteropod and Lamellibranch shells, dead or alive, it is evident that this particular species has not departed so widely from the habit of its kind.

Before describing the interesting breeding habits of this commensal Annelid, we will give an account of its structure and of certain organs especially illustrated in the figures.

The body (Fig. 2) is about a millimeter wide, about twenty-five long, and rather flat, with little color except the bright red of the blood in the conspicuous dorsal vessel and in the branchiæ. These reach half way across the back, and each contains a vascular loop that passes from the dorsal vessel to the tip of the branchia, then back again into the body. The limb of this loop nearer the middle line or to the dorsal surface may possibly act

as a heart, since it contains peculiar branching, nucleated protoplasmic processes suggesting the cells of an embryonic vertebrate heart, and to be interpreted as part of a mesenchyme, formed, like the blood, outside the cœlom. The ventral side of each branchia, that next the animal's back, bears along it a band of large ciliated cells, each with a large tuft of fine cilia. A similar row of such cells is found extending transversely across the back of each somite, and corresponding nearly to the lines of attachment of the internal septa. The branchia begin upon the sixth somite (Fig. 7), and are present, though very small, at the posterior end of the body (Fig. 8).

The setæ in the dorsal bundles are attenuated, lance-like, and straight (Fig. 3), while in the ventral bundles they present bifid tips, provided with a delicate scroll or enveloping hood (Fig. 4), except anteriorly, where they are entirely replaced by simple, lance-shaped, bent ones (Fig. 5), each with a delicate flange on its convex side. The setæ of the large fifth somite (Fig. 6) are especially modified as a set of about six very stout, golden-colored hooks, each with a prominent flange projecting from its side near the tip. In the figure some of these hooks are still young, and growing up into place beside the perfected ones. In addition to these large spines, there are a few delicate, lance-shaped ones, as seen in the same figure.

The shape of the animal's head is not easily made out, as it is drawn back into the first somite upon the slightest disturbance, and generally remains there in preserved specimens. In Fig. 7 its general form, as made out from living specimens, is represented somewhat imperfectly.

The cephalic lobe or head is slightly emarginate anteriorly, and bears two delicate antennæ that stand just dorsal to the mouth, as a part of the upper lip, and are richly supplied with sensory hairs. In the head are also two pairs of black eyes that on section appear to have only a simple larval structure. Each consists of a minute mass of large, dark-brown pigment granules, forming a sort of cup about fifteen microns in diameter, and partly surrounding a homogeneous spherical mass of equal size, that stains darkly. All this lies some distance from the surface, and

may be said to be in the dorsal part of the brain, since the brain is not separated from the epidermis, but lies with its dorsal ganglion cells intermixed with the epithelial cells, in part at least.

As far as the sections go, the appearance of the eye is so simple as to suggest that it may be interpreted as merely one or two epidermal cells, with clear, refracting outer ends, and pigment in the middle part. The inner tips of such cells may be supposed to connect with the brain. It is to be noted, also, that the same sort of pigment granules occur here and there in neighboring epidermal cells in small collections or isolated.

Posterior to the head are the two great tentacles, with a ciliated groove on the under side; while below, on each side of the mouth, is a very prominent, glandular, lateral projection of considerable size. The pharynx is ciliated, and may be everted with definite ridges and grooves between the above two lateral lobes.

At the posterior end of the body (Fig. 8) there is a peculiar series of about fourteen papillæ, placed about an elliptical area, within which the digestive tract terminates in a longitudinal slit.

In the internal anatomy of this Annelid there is one fact of considerable interest,—that is the dorsal opening of the excretory tubes, the nephridia. From the ciliated internal opening of each nephridium (Fig. 9) a somewhat coiled tube proceeds dorsally to make its way between the dorsal longitudinal muscle and the adjacent epidermis, and then, passing towards the middle of the back, opens finally by a small ciliated orifice not far from the median line and about mid-way from one end of the somite to the other. This is shown in a very diagrammatic way in the figure as made out in several sections of preserved specimens.

This dorsal position of the external nephridial openings is very unusual among Annelids, but is not confined to this species nor to those closely related to it. Thus, though the statement of Ehlers concerning numerous dorsal openings in Polynoe seem to have been negatived by the observations of Haswell, Bourne, and Kaltenbach, and those described by Cosmovici in Sthenelais and Hermione may also need investigation, yet other cases seem surely established. Such are the single dorsal openings, anteriorly, in certain Hermellidæ and Serpulacea, the dorsal openings

in some of the Capitellidæ, as well as those somewhat dorsal ones in Chætopterus, according to both older observations and the recent account of Joyeux Laffuie. In the Spionidæ, finally, we find dorsal openings recorded by Jacobi in 1883 for two species of Polydora.

That these openings have secondarily moved up from a ventral through a more lateral position to the dorsal one seems to be at present a more probable assumption, considering such lateral openings as those found in Polyophthalmus and the various positions present in different somites of Chætopterus, than that the dorsal lateral and ventral nephridial openings refer back to some ancestral condition where numerous nephridial tubes were present as in certain earthworms.

In the above diagram (Fig. 9) the nerve cord is also shown as two separate strands, each retaining its primitive position within the epidermis; anteriorly, however, the two cords come close together on the ventral mid-line.

A few facts regarding the breeding habits and development of this commensal Annelid also came under observation during July and August, and might be observed, presumably, through a larger part of the summer.

The eggs are laid in peculiar transparent cases within the part of the shell occupied by the Annelid, either in the tunnel or in the manufactured tube, or in both. These cases consist of elongated series of sacs, firmly united into cylindrical masses fastened to the walls of the tube in which they are built. As shown in Fig. 10, each sac or chamber of the case contains a very large number of eggs, of a yellowish color, and often has an irregular stalk on one side that evidently represents the place of final closure when the secreted sac was finished. The entire structure reminds one forcibly of similar egg-cases in certain Molluscs; moreover, as in those animals, we find here also irregularities at the end of the series of sacs. Thus the terminal sacs (Fig. 11) are smaller, contain few eggs, are often quite defective in shape, and may be so aborted as to contain no eggs at all. The eggs also, full of yellow yolk and presenting large irregular cleavage cells, add to this resemblance.

The cleavage of the eggs is complete but unequal, and results in a few large cells full of yolk becoming covered over apparently by smaller cells containing less yolk. The resulting larvæ remain for a long time within the egg-sacs, closely crowded together. At an early stage these larvæ are probably about the same as the pear-shaped larva of Leucodora figured by Mecznicknow in 1865, and may be regarded as trochospheres much distended by food-yolk. Such a stage is represented from a ventral view in Fig. 12, where the large triangular mouth lies at the bottom of a ciliated depression of the small anterior end, while the main rounded mass is filled with food-yolk showing imperfectly the outlines of a few large entoderm cells. A ventral ciliated band is present, as well as an imperfect post-oral ring, or rather two lateral ciliated areas, since, as in some other Annelid larvæ, the cilia are absent in the median area, both dorsally and ventrally.

Sections of this larva (Fig. 13) show that there is an outer ectodermal layer surrounding the entodermal yolk,—in which latter, however, the cell outlines do not appear,—that there is a paired mesoblast, and that the œsophagus ends blindly in the yolk mass. Moreover, sections to one side of the median plane show peculiar, large, ciliated cells, about the mouth, of which there is an especially large pair just posterior to the mouth. One of these is seen in the figure.

These larvæ are about .02 mm. long, and pass gradually into a stage with three pairs of setæ bundles and a length of .35 mm. These latter have four eye spots, an additional band of cilia anterior to the anus, but still a large mass of yolk in the thick walls of the digestive tract, surrounded by the body-cavity.

This stage with three pairs of setæ bundles is found for a long time, though much growth in the size of the body takes place, and conspicuous pigment areas appear when the late larval form such as shown in Fig. 14 results. The occurrence of this phase of larval growth, in which three somites are functional for some time, has been observed in several Annelid larvæ, and is suggestive from its resemblance to the Nauplius condition of certain Arthropods.

These older larvæ are found inside the Annelid's dwelling, sometimes in company with younger larvæ and even eggs, though it is probable that they escape out into the water about this stage. In swimming about the provisional setæ are brought into play as organs of defense, apparently, being thrown out at right angles to the body when the animal is disturbed, and trailed a ng close to its sides when it swims quietly by means of the cilia. These setæ are noticably barbed, excessively long, and unlike the adult setæ; forming a good illustration of the *provisional* Annelid seta.

This larva is conspicuous from the metamerically placed dorsal pigment blotches, which, it will be noticed, precede the external appearance of the somites, and are, moreover, represented upon the heart by a pair of small black areas near the eyes.

The digestive tract now presents three well-marked divisions —a mouth and short, ciliated œsophagus leading abruptly into a capacious intestine, with some yolk in its walls yet, and opening posteriorly into a short rectum that ends at the anus. Here there are two papillæ with long sensory hairs, such as also occur in a tuft upon the median part of the head.

In sectioning the adult Polydora, eggs in various stages of formation are found within the body-cavity. The ovary, in fact, appears as a mere mass of modified peritoneal cells, attached to and covering over the vascular loops near the nephridia (Fig. 9). The youngest ova do not differ perceptibly from the ordinary peritoneal cells over the blood-vessels, but they soon enlarge and become more and more filled up by accumulating yolk globules. In this way there is formed a large botryoidal mass of large and small cells (ova), projecting freely into the body-cavity, and not covered by any membrane. Thus attached to blood-vessels, the ova attain a diameter of .06 mm., and then break loose into and float freely in the body cavity (Fig. 9.) Here they continue to grow till, when apparently ripe, they have a diameter of .09 mm. In the ovum there is a large nucleus, nearly .02 mm. thick, and a very conspicuous nucleolus five microns in diameter. This nucleolus is peculiar in having one or more rounded elevations or lateral protuberances upon it, which may be half as thick as the main body of the nucleolus.

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The striking parts of the nucleolus are, I presume, described by Vejdovsky in Sternaspis as "bückelchen," but declared by Giard, in his remarkable observations upon Spio, to be the result of fusion of certain extra nuclear "cells" with the proper nucleolus. The body of the ovum is full of large yolk-spheres, staining dark with osmic acid, and having an average diameter of perhaps 2 microns. Presumably the eggs pass from the body-cavity by the nephridia, but no observations were made upon this point.

Since the eggs, when laid, are concealed within a tortuous passage removed from the external water, and as all the large Annelids examined are females living solitary, one in each shell, there seems a need for some special means of insuring the fertilization of these eggs. In fact, some shells contain, besides the large female, a minute individual about 4 mm. long, which it was thought might be a male. The only one preserved and sectioned, however, does not suffice to decide this question. In its body-cavity there are, however, numerous cells and cilia that strongly suggest spermatozoa in process of formation; and if this be the case, we would have here an interesting case of dimorphism, at least of great discrepancy in size, between the two sexes. Moreover, these small Annelids may occur in many more cases than actually observed, no special attention being given to their detection at that time. If males, living thus in the dwelling of the female, they would furnish a ready solution of the above difficulty in regard to the fertilization of the eggs.

I have not succeeded in finding this commensal Annelid in the shells inhabited by the same hermit crab upon the New England coast, and believe that it, like many other of our southern forms, is an undescribed species, and would suggest the name *commensalis* asdescriptive of its peculiar habits. Its chief characters would be asfollows:

Polydora commensalis, sp. n.

The female (Figs. 2–8). Cephalic lobe usually retracted, slightly emarginate, bearing minute sensory antennæ anteriorily and four black eyes dorsally, the posterior pair nearer together. Tentacles in contraction, as long as the body is wide. Body flattened, of about 100 somites; length, 25 mm.; width, 1 mm.; colorless, translucent posteriorly, intestine dark, blood-vessels conspicuous.

PLATE II.

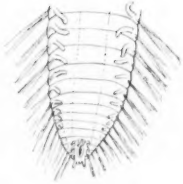

FIG. 8.

FIG. 9.

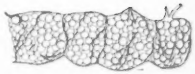

FIG. 10.

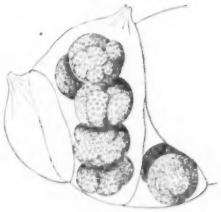

FIG. 11.

FIG. 12.

FIG. 13.

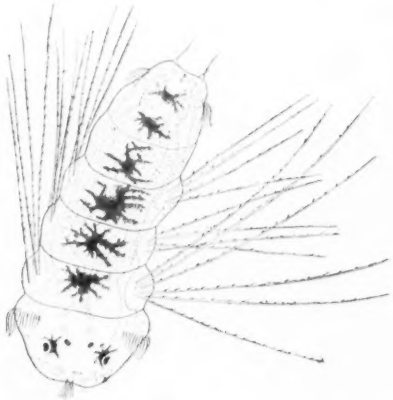

FIG. 14.

Polydora commensalis.

Branchiæ begin on the sixth somite, increase rapidly to equal half width of body, and diminish rapidly near posterior end of body; each has a line of large ciliated cells, as also does the dorsal surface of each somite. Anus surrounded by about 14 papillæ on each side,—a short posterior one, a much longer one, four shorter anterior, and then one still shorter. Dorsal setæ long, acuminate (Fig. 3); ventral setæ curved and with a flange (Fig. 5) till the twelfth somite is reached, then gradually replaced by an increasing number of forked setæ (Fig. 4); setæ of fifth somite six yellow hooks, each with a sharp flange on side near tip, and also a cluster of delicate hair-setæ. Found at Beaufort, N. C., living as a commensal in holes excavated in Gasteropod shells inhabited by *Eupagurus pollicaris* and overgrown by Hydractinia. Eggs laid in series of cases inside these dwellings; larvæ as in Figs. 12–14. Male thought to be much smaller than the above female form, and to live in the same shell.

EXPLANATION OF FIGURES.

FIG. 1.—Shell of Ilyanassa, cut open to show the openings into the columella and the built-up passage in the cavity of the shell on the left, all made by Polydora. × eight diameters.

FIG. 2.—General appearance of *P. commensalis*, dorsal view, preserved specimens. (Camera, Zeiss. 4 A).

FIG. 3.—Ends of dorsal setæ. (Camera, Zeiss. 4 F.)

FIG. 4.—Forked ventral setæ, with flange. (Camera, Zeiss. 4 F.)

FIG. 5.—Pointed, anterior, ventral setæ. (Camera, Zeiss. 4 F.)

FIG. 6.—Setæ of left side in fourth segment. (Camera, Zeiss. 2 D.)

FIG. 7.—Anterior region of the body. (Camera, Zeiss. 2 A.)

FIG. 8.—Posterior end of body. (Camera, Zeiss. 2 A.)

FIG. 9.—Diagram of cross-sections of body, showing dorsal openings of nephridia, separate nerve-cords, ovary and free ova, digestive tract and blood-vessels, parapodia, muscles, and branchia. (Camera, Zeiss. 2 A.)

FIG. 10.—Part of an egg-case, showing eggs in several chambers. (Camera, Zeiss. 2 A.)

FIG. 11.—End of such a case, showing aborted chambers and cleaving eggs. (Camera, Zeiss. 2 D.)

FIG. 12.—Larva, ventral view. (Camera, Zeiss. 4 G.)

FIG. 13.—Vertical, longitudinal, but not median section of Fig. 12. (Camera, Zeiss. 2 F.)

FIG. 14.—Advanced larva, showing provisional setæ and metamerically arranged pigment blotches. (Camera, Zeiss. 4 G.)

EDITORIAL.

EVERY attempt of our common-school teachers to better their intellectual condition is to be commended, and every step honestly and advisedly taken with that end in view should be encouraged by all. So, in the abstract, we have the greatest interest in the formation of "reading circles" and compulsory teachers' institutes among the teachers of Indiana, for the object is a worthy one. Further than this we cannot go, for the means adopted, so far as science is concerned, could not be worse. Indeed, it is so bad that it almost looks as if the "practical politics" which successful book agents are adepts in had been employed here. To explain: Every teacher is compelled, under certain inducements and penalties, to attend one institute each month, and is obliged to come prepared to discuss and answer questions upon some given subject of school work. The subjects change from year to year, and with the change new books are to be bought. As there are 30,000 copies of each book to be supplied to these reading circles, it is readily seen that the getting of a book on the list means no little profit.

It would be thought that in a matter of so much importance the opinions of experts would be called in to aid in selection, but this was apparently not the case. Both zoology and botany have several good students in Indiana; but so far as heard from not one was consulted in the matter, as can readily be imagined when one learns that the books selected were Steele's "Zoology" and Wood's "How to Study Plants." Certainly no two books could have been selected which were further removed from what text-books should be,—books without a single redeeming feature; books which are conspicuous examples of how not to do it. To render them more useless (if that be possible), some ignoramus has been employed to write up an analysis of each, laying out for each meeting of the institutes the subjects for work and questions for the same. Were the results not so lamentable they would be laughable, and even as it is we hope that readers can

gain a grain of amusement from some of the examples that appear below. Still, it must be borne in mind that many thousand teachers have been imposed upon by the cupidity or stupidity of some one in authority.

This year the study is botany, and the work is laid out for each month, but with the least possible expenditure of brain energy on the part of him who evolved the synopsis. He has taken from some other scheme a list of plants and months, and has shifted them about so as to meet the needs of the institutes, but without any regard to seasons. Thus in November the poor teachers are expected to study the dog-tooth violet! while in January the flower and fruit of the strawberry are the subjects of discussion. In December the teachers will be searching their gardens for flowering tulips, and scanning the orchards for the beautiful blossoms of the apple and peach. Could any arrangement be more absurd?

Then the same wise head has thought that technical terms are too strong food for the poor school teacher, and he has therefore tried to translate them into the vernacular. The result can be imagined. In speaking of the mode of branching of the apple tree the term deliquescent is used, but this was too big, too abstruse; so the dictionary has been invoked and a synonym sought, and the poor teacher is requested to notice the "solvent trunk" of the apple tree.

Zoology was studied in the year 1889–'90, and so the mischief is done. Still, we cannot refrain from calling attention to a few points. We miss, it is true, the incongruity between subject and season so prominent on the botanical side, but we find ample compensation in the nonsensical character of the questions. We can imagine some poor teacher turning over the pages of the zoology trying to find the meaning of the term "*homologom*"[1] (*sic*) which he or she is expected to define. Imagine the intellectual drill and the knowledge of zoology which one will get in learning the answers to the following questions selected from a hundred and fifty of similar character: Describe the classification of any branch of the animal kingdom. In what animals do we first find

[1] A friend suggests that this is a mouthful of hot pudding. We are inclined to think it a misprint for homologous.

the sensation of sound produced? What makes the hammer oyster of peculiar interest? Show how the dragon-fly comes into existence. What insects are called the quakers? What is the Sly Silurus? why so called? What superstition was held by sailors in regard to the petrel? What bird has at times been converted by the natives into a lamp? Describe the song of the bobolink. Describe the unicorn. To what use did the Indians put the enamel of beavers' teeth? How does the whale manage to live in the water? Give the significance of the term "snake charmer." What does the author think should be required of students in the study of birds? The answer to the last question is given as an example of the unmitigated bosh of the whole text-book:

"The following is taken from Baird, Brewer, and Ridgway, as a specimen of what every thorough teacher will require from each of his pupils in writing, with simple sketches attached, for every bird that can be obtained in the immediate vicinity: *Turdus migratorius*, Robin, American Redbreast. Tail slightly rounded; above olive-gray, top and sides of head black, chin and throat white"; and so on through a technical description which no *thorough* teacher would ever dream of demanding from any pupil.

The incoming superintendent of public instruction in Indiana is said to be a man of ideas. Certainly one of the first things he should do is to use his position and his influence to put an end to this state of affairs, and to see that in future specialists are employed to select books,—specialists who are proof against the dulcet tones and the frequently more solid arguments of the publishing house.

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——Beginnings of the Classical Heroic Couplet in England. Reprint from *Am. Journ. Philology*. From the author.

WOODWARD, A.—Synopsis of the Cretaceous Foraminifera of New Jersey. Extract Proc. New York Microscopical Soc. From the author.

RECENT LITERATURE.

Hyatt's Insects.[1]—The small volume before us is the eighth in the series of Guides for Science-Teaching issued under the auspices of the Boston Society of Natural History. The series has been rather unequal; some of the numbers, noticeably that dealing with the Crustacea and spiders, have fallen below what such guides should be; but the present volume has gone as far the other way, and makes an admirable introduction to the study of entomology. With this and the still unfinished work of Professor Comstock, already noticed in these pages, the beginning students of insects can enter upon their work and fit themselves to take up the more technical papers.

The treatment of the subject is after the following outline: The grasshopper is made the type of the group of Hexapods, and outlines are given to aid the student in working out for himself the external and internal anatomy. Next follows a chapter upon the principles underlying classification, and then come the characteristics of the fourteen orders which, following Brauer, the authors have recognized. There are many things in this arrangement which please us, but we cannot agree to it in all particulars. Larval stages are an introduced feature in the Hexapod phylum, and those who rely wholly upon them as guides to the affinities and relationships are apt to go astray. Thus the facts hardly seem to warrant the close association of Lepidoptera, Hymenoptera, and Diptera, with the Hymenoptera occupying a position intermediate between the other two; nor can we agree that the May flies are, the Thysanura excepted, the lowest of the Hexapods. There are also other features of detail where we think the authors are at fault, such as the statement (p. 18) that the cerci are not true appendages. We could wish that the authors had availed themselves more of the admirable summary of Hexapod anatomy given in Lang's "Vergleichende Anatomie." On page 12 Professor Hyatt says that he is "disposed to uphold a modified form of the Cuvierian classification. The old names, Radiata, Mollusca, and Articulata, like the name Vertebrata, represent obvious relations and a legitimate grouping of forms." We had thought that the heterogeneous character of the old group Radiata had long ago been demonstrated; while if Professor Hyatt wishes to include metameric forms under the name

[1] Guides for Science-Teaching, No. VIII. Insecta. By Alpheus Hyatt and J. M. Arms. 16mo, pp. xxiii. + 300. Boston, D. C. Heath & Co., 1890.

Articulata, he will be obliged to throw out the Plathelminthes and Nematoid forms, while, on the other hand, his group of Vertebrates will disappear, along with "Vermes" (= Annelids) and Arthropods, in the group for which others have adopted the term Metamerata.

These are, however, but minor points. The good features of the book are many, and Professor Hyatt is to be congratulated in the able coadjutor (or coadjutrix) he has found in Miss Arms. Many of the 223 illustrations are fresh, but there are also some of the old acquaintances. We think the book the best of its kind yet issued, but we cannot help wishing that we had some really first-class text-book of entomology which would attack the subject from every side. For points of structure the student has still to be referred to Newport's article "Insecta" in Todd's "Encyclopædia of Anatomy and Physiology," while for the systematic aspect there is as yet nothing to replace Gerstäcker's account in Carus and Gerstäcker's "Handbuch der Zoologie," or that given in Ludwig's edition of Leunis's "Synopsis."—J. S. K.

General Notes.

GEOLOGY AND PALEONTOLOGY.

A Review of the Discovery of the Cretaceous Mammalia.[1] The following is an abstract of a review of "The Discovery of of the Cretaceous Mammalia," presented to the Society of Morphologists, December 30th, 1890. The review is mainly an analysis of the types upon which the author bases his systematic classification of the collection of mammalian teeth and other parts from the Laramie beds. These mammals are provisionally referred by the author to four mammalian orders and eight families, five of which are new to science. Sixteen new genera and twenty-seven new species are also proposed.

It appears that before accepting this system we must eliminate: 1. The terms preoccupied by other authors. 2. The terms founded upon different parts of the same animal, and thus largely preoccupied by the author. 3. The terms founded upon imperfect or indefinite types. 4. The terms founded upon reptilian or icthyopsidan teeth. This may be expressed as follows:

A. ALLOTHERIA. . . . . MULTITUBERCULATA, Cope.

1. *Cimolomidæ.*
   Cimolomys gracilis.
   Cimolomys bellus.
   Cimolomys digona
2. *Cimolodontidæ.*
   Cimolodon nitidus.
   Nanomys minutus.
3. *Plagiaulacidæ.*
   Halodon sculptus.
   Halodon serratus.
   Halodon formosus.

. . . . . *Plagiaulacidæ.* Cimolomys, 2 or 3 species.

[1] The Discovery of the Cretaceous Mammalia. O. C. Marsh, *American Journal Science and Arts*, Parts I. and II., July and August, 1889.

4. *Dipriodontidæ.*	
Dipriodon robustus.	
Dipriodon lunatus.	
5. *Tripriodontidæ.*	*Stereognathidæ.*
Tripriodon cœlatus.	. . . . . Meniscoëssus, Cope, 2 species.
Tripriodon caperatus.	
Selenacodon fragilis.	
Selenacodon brevis.	
6. *Allodontidæ.*	
Allacodon lentus.	. . . . . Probably preoccupied above.
Allacodon pumilus.	
Camptomus amplus	. . . . . Probably preoccupied above.
Oracodon anceps.	. . . . . Indefinite type, or preoccupied.
?B. PANTOTHERIA.	. . . . . Not defined.
?7. *Dryolestidæ.*	. . . . . Determination uncertain.
?Dryolestes tenax.	
C. MARSUPIALIA.	. . . . . Order indeterminable.
Didelphops vorax.	
Didelphops ferus.	. . . . . Didelphops. Not definable.
Didelphops comptus.	
Cimolestes incisus.	. . . . . Cimolestes. Not definable.
Cimolestes curtus.	
D. INSECTIVORA.	. . . . . Order indeterminable. Genus
Pediomys elegans.	not defined.
E. INCERTÆ SEDIS.	
8. *Stagodontidæ.*	. . . . . Reptilian or icthyopsidan
Stagodon nitor.	types.
Platacodon nanus.	

The full analysis upon which these conclusions are based will be published subsequently.

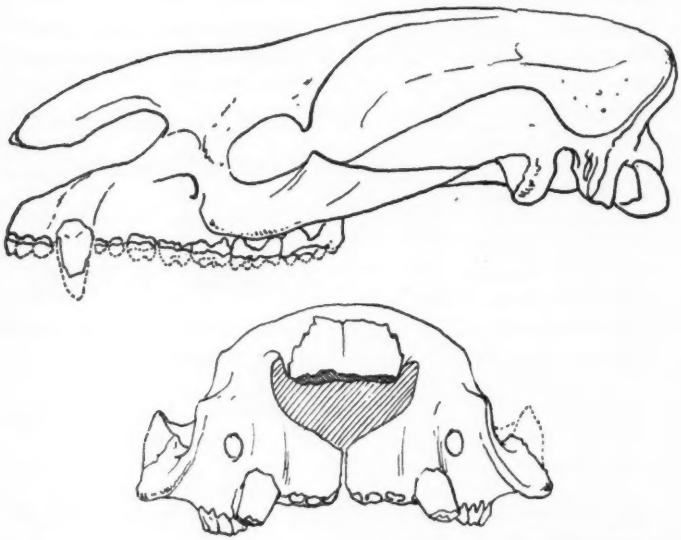
HENRY F. OSBORN.

January 26, 1891.

On a New Species of Palæosyops.—*Palæosyops megarhinus*, sp. nov.—This new species of Palæosyops is established upon a fine skull (No. 10,008) in the Princeton collection from the Washakie Eocene of Wyoming; there is also another portion of a skull (No. 10,041), probably belonging to this species, with the occiput well preserved, from the Bridger proper.

Cranium.—The characters of this skull are quite unique, and depart widely from any of the species of the family that I have examined.

The general form of the skull is broad and depressed. Its dorsal contour is very like that of *Palæotherium crassum*,—namely, there is no frontal depression, which is so characteristic of *Palæosyops paludosus*, and the occipital region is only slightly higher than the frontal. The temporal fossæ are not deeply excavated, and the occipital crests are weakly developed when compared to this region of the skull in Limnohyops. The occiput itself is high and rather narrow. The foramen magnum is wide, bordered by very large condyles. The auditory processes are widely separated. The post-tympanics are broad and heavy. The post-glenoid is peculiar in form; it is very short and



Palæosyops megarhinus, sp. nov.; anterior and lateral view of skull; from the Washakie Eocene of Wyoming.

thick; its form is very different from other species in the collection. An internal glenoid process is present in this species. The mastoid was probably exposed. The form of the zygomatic arch is striking; it is very light, nearly straight, with the temporal portion strongly compressed. The malar portion is also peculiar; the malar insertion is very abrupt and strongly depressed, with the external part very broad, thin, and shelf-like. The infra-orbital foramen is not exposed. The form of the malar in this species is totally different from all other allied forms

that I have examined. The orbit is very small, terminates anteriorly above the anterior border of the second superior molar; the post-orbital processes are well marked. The facial region of the skull is very short, compared to the total length of the cranium. The nasals are very long and heavy; their distal portion is expanded and broader than the middle part. The nasal notches are very deep and high. The premaxillaries are triangular in outline; their symphysis is short and narrow, with a prominent anterior keel. The canine alveolus is very prominent. The palate is long and narrow, the roof of the same being strongly arched. The posterior termination of the palate is at the second superior molar. The incisive foramina are not divided.

Teeth.—The crowns of the teeth in this skull are badly damaged, but enough remains to give the total measurements and the characters of the last molar. The superior molars in this species form a continuous series, being not interrupted by a diastema. The sections of the incisors are very small. The canines are also very small, and diverge widely. Only the second and third molar of each side are partially preserved. They have a square form with low crowns; externally they are totally without a cingulum. The external V's are rather wide and angular, in this respect approaching that of Telmatotherium. The last molar is without any intermediate conules.

Measurements.—1. Length of skull, from premaxillary symphysis to end post-glenoid 285
2. Length from orbit to premaxillary symphysis 125
3. Length from orbit to post-glenoid 160
4. Depth of nasal notch 084
5. Length of nasals 100
6. Entire molar series 148
7. Last super. molar { ant. post . . . . . .037 / trans. 039

E. M. Museum, Princeton College. CHARLES EARLE.

On Two New Perissodactyles from the White-River Neocene of Nebraska.—Dr. Hobart Hare, of the University of Pennsylvania, recently presented to the Museum of the University a collection of fossils from the White-River Neocene beds of Northern Nebraska. This includes parts of skeletons of *Stylemys nebrascensis* Leidy, and *Menodus americanus* Leidy, with some others, among which are two species evidently new to science. One of these is a rhinoceros of the genus Cœnopus Cope, of larger size than any of those hitherto known, and the other is a remarkable species of Menodus, which is

characterized by a development of the horn-cores so far unique in the genus. I characterize it under the name of

MENODUS PELTOCERAS sp. nov.—Represented by the nasal region and the horn-cores; the apex of one of the latter being broken away. The peculiarity of the species consists in the immense transverse extent of the horn-cores, and their complete fusion into an osseous wall which extends across the muzzle, forming a huge plate or shield. The superior border of this shield is moderately concave, a protuberant angle on each side representing the apex of each horn-core. The nasal bones form a flattened protuberance much wider than long, which overhangs the nares. Their superior wall slopes directly upwards from the obtuse apex to the crest of the horn-core-plate. The expanse of the base of each horn-core outside of the nares is as wide as the nasal meatus, is flattened from before backwards, and has a narrow external margin. The horn-core-plate is vertical behind at the slightly angulated middle line, and is moderately concave on each side, the apex being slightly recurved. Measurements: Elevation of horn-core-plate at middle line behind, 180 mm.; do. at lateral apex, 190 mm.; total width of do. at middle, 300 mm. Projection of nasal bones beyond lateral base of horn-core-plate, 20 mm.; width of nasal meatus at base of nasal bones, 65 mm.; width of base of horn-core-plate outside of nasal meatus, 90 mm Anteroposterior diameter of base of horn-core above side of and parallel to nasal meatus, 85 mm. This species is nearest the *M. platyceras* S. & O., which has transverse compressed horn-cores. They are, however, distinct from each other, and not nearly so expanded transversely as in the present form. The *M. peltoceras*, in fact, carried a transverse shield on the end of its nose, which must have given it an extraordinary appearance.

CÆNOPUS SIMPLICIDENS sp. nov.—Represented by the last two superior molars of the left side, with a probable humerus and femur. The molar teeth are one-third larger in linear dimensions than those of the *C. occidentalis* Leidy, and lack the external basal cingulum which is present in the corresponding teeth of that species. Internal cingulum wanting, but the anterior and posterior cingula present. The posterior limb of the metacone is represented in the posterior molar by a tubercle at the base of the crown, which rises into a a low ridge which soon disappears. It bounds a fossa with the posterior cingulum just behind it. Transverse crests simple, with a convexity representing the anti-crochet. Paracone distinct, separated by an open groove from the anterior angular cone. Both limbs of the metacone of the penultimate molar are well developed. Measurements: Transverse diameter

of M. ii. at anterior cross-crest, 48 mm.; do. at posterior cross-crest, 38 mm.; do. of M. iii. at anterior cross-crest, 45 mm.; anteroposterior diameter of do. at inner base of crown, 42 mm.—E. D. COPE.

The Tertiary Formations of Western Texas.—Mr. Robert T. Hill has made brief mention in three short papers[1] of a very interesting fact concerning the age of the Staked Plains, and the extent of the fresh-water Tertiary formations of the West eastward into the Texas region. The whole of the great mesa known as the Llano Estocado and some of the basins of the Trans-Pecos region, near El Paso, are composed of the sandy loams, grits, and pebbles of this formation. This area in Western Texas and Eastern New Mexico extends in places eastward to the one hundredth meridian, and is a direct continuation southward of the same formation in Kansas and Nebraska. Its southern limit on the Rio Grande is near Del Rio, and the whole area, which is as large as New England, has hitherto been colored Cretaceous and Jurassic upon previous maps. The formation has afforded fossil bones in various places; but these as yet have been unstudied. It rests unconformably upon the Comanche series, the Jura Trias, and the various rocks in the mountain ridges. Everywhere at its base it affords an abundant supply of well water, which has proved of great value to the settlers who are now rapidly locating on the Staked Plains. The Fort Worth and Denver road traverses the formation from Clarendon to Tascosa, and the Texas Pacific from Sweetwater to the Colorado valley, and from thence westward. This additional knowledge upon the former extent of the great inland lakes of Tertiary times is important in that it nearly doubles the areal extent hitherto acknowledged, and enables us to locate the narrow continental divide between the Gulf of Mexico and the Tertiary lakes with greater accuracy. Dr. Otto Lerch has corroborated the extent of these beds in a recent article on the Concho country, in the *American Geologist* for 1890. The great development of this terrane in Southern New Mexico, was pointed out by Prof. Cope, in the Proceedings of the Amer. Philos. Society, 1883, p. 308.

The Eighth Volume of Reports of the Geological Survey of Illinois left the press in July last. The general distribution of the edition—5,000 copies—must, however, be postponed until the Legislature of the State will have provided for its binding. Only fifty copies have been bound in advance, and we have received one of them. We will give a full notice in future number of the NATURALIST.

[1] Notes on the Geology of Western Texas. Bulletin Texas State Geological Soc., September, 1888. Pro. Am. Ass. Adv. of Science, Toronto, 1889.—Topography and Geology of Texas Region. *Am. Geologist*, Jan., 1890.

BOTANY.

Books for Young Collectors.—It is probable that the professional botantist too generally underrates the value of the books designed to aid the young collector. The untechnical and popular style rarely pleases the learned botanist, who long since passed beyond the need of such simple pabulum. But many a young man who is not able to go to college eagerly longs to make a beginning in the work of studying the plants about him, needing only some suggestions as to ways and means. For such a student the "books for young collectors" are most useful.

A recent book by T. S. Smithson, entitled "Pond-Life: Algæ and Allied Forms," is a good illustration of what such a work should be. In the introductory chapter some suggestions are given as to the apparatus required, with instructions as to collecting, etc. This is followed by a popular description of the more common fresh-water algæ, with suggestions as to their treatment. The earnest student can get much help from the book.

A Study of the Snow-Plant.—Professor Oliver, of London, has studied the "snow-plant" (*Sarcodes sanguinea*) of the Pacific coast, and published his results in the *Annals of Botany* for August. After a general description of the plant, the various parts are taken up in detail. The roots are very interesting, being "coralline" in appearance, and covered with a close-fitting sheath of fungal mycelium, constituting a well-marked case of "mycorhiza." The structure of this fungal layer is carefully worked out, and comparisons are made with the similar structure in Monotropa. It appears from these investigations that Sarcodes is not parasitic upon the roots of surrounding plants, but that it is a saprophyte, living upon decaying matter in the soil, in which it is aided by the layer of fungal mycelium.

The stem and leaves show the usual "reduced" condition common in parasites and saprophytes. The flower is essentially like that of Monotropa, with certain minor variations. The pollen shows the two nuclei, viz., the vegetative and the generative, with unusual clearness. The former is spherical, while the latter is spindle-shaped. In an earlier stage the pollen-spore is actually divided into two cells, some of the figures given closely resembling the pollen-spores of the Coniferæ.

The ovules arise as small upgrowths of tissue on the young placenta by the formation of tangential divisions in the layer immediately below

the epidermis. At an early period the terminal cell of the hypodermal tissue of the young ovule is seen to be much larger than its neighbors, and is the "archesporium" from which by subsequent development the embryo-sac is to be formed. There is first cut off from the archesporium a single apical cell, and this is followed by another division, thus making a row of three cells, the lowermost of which is the embryo-sac. The latter enlarges and elongates, crowding the cap-cells until they are mere plates.

In the embryo-sac the nucleus divides, each part moving to an opposite extremity, where it divides again, and still again. At this stage there are four nuclei at each end of the embryo-sac. One of these at the micropylar end becomes the germ-cell (egg-cell, oösphere), two become the synergidæ, while the fourth moves downward, and, fusing with an ascending one from the opposite end, forms the nucleus of the first cell of the endosperm. After fertilization the germ-cell and endosperm-cell divide, forming embryo and endosperm.—CHARLES E. BESSEY.

The Annual Report of the State Botanist of New York. —This report from C. H. Peck, bearing date of December, 1889, contains much of interest to the technical botanist. Many new species of fungi are described and figured. Of these the majority are Agaricini, there being no less than eleven new species, belonging to seven different genera. Two new Myxomycetes are figured and described, viz., *Comatricha longa* and *C. subcæspitosa*. An interesting Plasmopara (*P. viburni*) is described as occurring on *Viburnum dentatum*. The author says that it is evidently very near to *P. viticola*, "of which it may prove to be only a variety." A curious new genus allied to Helvella is characterized under the name of Underwoodia, in honor of Professor L. M. Underwood, who communicated the specimens. The single species (*U. columnaris*) is a columnar, horn-shaped "receptacle," from four to six inches in height.

Among the "remarks and observations" the author says of the entire-leaved variety of *Rhus toxicodendron*, that "it has been reported to me as comparatively harmless so far as poisonous quality is concerned, and my experience in handling it was entirely without harm." —CHARLES E. BESSEY.

How to Know Grasses by Their Leaves. — Professor McAlpine, of Edinburgh, has written a useful little book of ninety-two pages upon the topic given above, intending it to be a simple guide to the identification of the common grasses by their leaves

alone. For the practical man who wishes to know what grass is growing in his meadows and pastures this book will prove of great value; and even to the botanist it will often be quite useful. The author says in his introduction: "If farmers, clergymen, schoolmasters, and botanists use this method of identification a flood of light will be thrown upon many questions at present involved in obscurity, and the agricultural community will assuredly be greatly benefited.

In the treatment of the subject fourteen "groups" of grasses are defined as follows:

I. Characteristically colored grasses.
II. Variegated grasses.
III. Bulbous grasses.
IV. Cord-rooted grasses.
V. Acute-sheathed grasses.
VI. Net-sheathed grasses.
VII. Bitter-tasted grasses.
VIII. Bristle-bladed grasses.
IX. Hard-bladed grasses.
X. Hairy grasses.
XI. Eared grasses.
XII. Ribless-bladed grasses, with median lines.
XIII. Hairless grasses, with very low and flat ribs.
XIV. Ribs high and prominent, rounded, or acute.

Many good figures are given, thus greatly aiding the student. An admirable feature of the figures is the frequency with which cross-sections of leaves are given. Ligules and leaf-tips are also freely figured. The work, although written for England, will be useful in this country.—CHARLES E. BESSEY.

ZOOLOGY.

Abnormal Repetition of Parts.—Bateson has figured[1] some interesting cases of monstrosities of this sort. In *Cancer pagurus* he finds an external maxilliped which has been converted into a pincer like that of the large claw. In other specimens of the same species he finds three specimens in which the pincer has a tendency to duplicate itself, as is well known to those who have studied these malformations. Another instance is a specimen of *Chrysomela banksii*, with three tarse on the right posterior leg. In a specimen of *Antedon rosacea* a pair of the arms show a branching into four at some distance from the body. The last case is a pilchard with an abnormal number of scales, No discussion is given of these instances, but Mr. Bateson has in progress an essay on the variation of multiple parts.

The Embryology of Spiders.—K. Kishinouye has been studying the development of some Japanese spiders. His descriptions of the early stages[2] are to be regarded as confirmative rather than making an important advance. At one stage he finds the yolk free from nuclei, the germ-layers arising later from the primitive cumulus and the posterior cloud of Claparède. He differs, however, in some points from Claparède and others in the interpretations of the early surface views. Among the interesting points brought out are the following: The first abdominal segment has no appendage at any stage. The lung books are developed in the base of the appendages of the second abdominal segment, in exactly the way necessary to support the view of their homology with the gill books of Limulus. An abortive trachea develops in the same way from next appendage. The coxal glands are shown to consist of a cœlomic pouch and an ectodermal duct,—a fact which goes far to support their homology with nephridia, and to lessen the weight of Eisig's argument. The author is convinced that the malpighian tubes are not ectodermal; he thinks them mesodermal, but apparently is not familiar with the results of those authors who assign them to the entodermal structures. Some facts additional to those of Locy are given regarding the development of the eyes. The stecoral pocket is regarded as developing from an unpaired posterior cœlomic pouch.

[1] Proc. Zool. Socy. London, 1890, p. 579.

[2] Journal of the College of Science, Imperial University, Japan, Vol. IV., 1890.

Insects of Central Africa.—H. Grose Smith catalogues[3] 111 species of Lepidoptera; W. L. Distant, 48 Rhynchota; and H. W. Bates, 73 Coleoptera, collected by William Bonney in the Great Forest of Central Africa while on the Emin Pasha relief expedition. The number of novelties is comparatively small, and the insect fauna shows very marked resemblances to that of the western coast of Africa.

Studies on Amphioxus.—F. E. Weiss has had the opportunity to study at Naples some points in the anatomy and physiology of Amphioxus which needed elucidation. The basis of his work was the paper by Professor Lankester,[4] in which many unsolved questions were pointed out. Weiss now settles[5] some of these. Feeding with carmine seems to show that there is not that intimate connection of cœlom with the vascular system that had been supposed. Many of the connections and relations of the circulatory tubes have been made out, while the most interesting discovery is that of excretory tubules, paired and branchiomeric, occurring at the upper part of the branchial apparatus, in connection with the secondary or tongue-bars. Each of these tubules is supplied with a comparatively large blood-vessel. It is bent in the shape of the letter S, and empties into the atrial cavity. Weiss was not certain whether it communicates with the cœlom or not, his sections failing to settle this point. These tubules are regarded as nephridial, but the author does not regard them as homologous with the pair of tubes described by Lankester. Another point of interest is that many points on the surface have also excretory functions.

The Amphibian Blastopore.—R. V. Erlanger has attacked this oft-studied problem, and concludes[6] that the anus is formed from the ventral, and the neurenteric canal and neuropore from the dorsal, margin of the blastopore. In the Anura the blastopore closes, and the anus later breaks through within its limits, while in the Urodeles there is no closing.

The Position of the Sun Grebes.—The systematic position of the Heliornithidæ has been very uncertain. Recently F. E. Beddard has had an opportunity of studying the anatomy of *Podica senegalensis*, and concludes[7] that if the muscles alone were concerned the sun grebes

[3] Proc. Zool. Soc. London, 1890.

[4] *Vide* AMERICAN NATURALIST, XXIII., p. 639, 1889.

[5] *Quart. Jour. Mic. Sci*, XXXI., p. 489, 1890.

[6] *Zool. Jarbuch*, Abth. Anat. und Ontogenie, IV., p. 239, 1890.

[7] Proc. Zool. Socy. London, 1890.

would be placed with the Pygopodes, but that osteology alone would refer them to the vicinity of the rails, though it differs from the latter in the sternum. The characters peculiar to the Heliornithidæ are the absence of an aftershaft, the form of the sternum, the shape and relations of the interclavicular, in the fusion of the pubes with the ischia, and the absence of post-acetabular ridges, in the arrangement of the intestinal coil, and in the form of the biceps crusis. On the whole, Beddard thinks it a distinct family, which has traversed for a certain distance the branch leading from the rails to the Colymbidæ, and has then diverged rather widely in a direction of its own.

Zoological Notes.—Cœlenterata.—The habits of the sea pens (Vergularia, etc.) have not been certainly known. Edgar Thurston says that near Madras *V. juncea* sticks straight up in the sand, and that as soon as touched they go down deeper and deeper, so that frequently a spade is necessary to secure them.

G. C. Bonme[8] gives a catalogue of 55 Hydroids growing at Plymouth, England. The only novelty is *Haloikema* (n.g.) *lankesterii*, a Halecium-like form with non-retractile polyps.

Molluscs.—The Opisthobranch molluscs of Plymouth, England, are catalogued[9] by Walter Garstang. Fifty-two species are enumerated, while very full notes are given of many species. The student of Nudibranchs on the New England coast cannot neglect this paper.

Vertebrates.—Some five years ago the discovery in Mauritius of a cave containing the body of the dodo was announced. It appears that this was probably a mistake, two recent letters[10] showing that the person making the announcement had been imposed upon. The caves of Mauritius are not such as to contain such remains, swept as they are by frequent floods.

Boulenger gives[11] a synopsis of the genus Arges, describing six species, two of which are new. They come from the Andes of Equador and Peru.

Howes believes that the proatlas is a normal feature in Hatteria, and regards it as a vestigial vertebra. He has found several specimens

[8] Jour. Marine Biol. Ass. United Kingdom, No. 4, p. 391, 1890.

[9] Jour. Marine Biol. Ass. United Kingdom, No. 4, p. 399, 1890.

[10] Proc. Zool. Socy. London, 1890, p. 402.

[11] Proc. Zool. Socy., 1890, p. 450.

of this form with the vomerine teeth, discovered by Baur, and refers to their relationship to similar teeth in Paleohatteria.

Dr. Emil Schoebel contributes[12] an account of the post-embryonic development of the eye of the Amphibia. The eye has almost all of its essential features at the beginning of larval life, and, contrary to the title of the paper, the author describes the features before as well as after hatching.

EMBRYOLOGY.[1]

A New Text-Book on the Embryology of Invertebrates.—Dr. E. Korshelt and Dr. K. Heider have recently published the first volume of a "Lehrbuch der Vergleichenden Entwicklungsgeschichte der Wirbellosen-Thiere" (Jena, 1890, Gustav Fishcher). Since the publication of Balfour's "Treatise on Comparative Embryology," written more than ten years ago, there have been published an immense number of papers dealing with the embryology of animals; and the authors believe there is a pressing need of bringing these together, and making a new inventory of the accumulated material. The present book is confined to the results on invertebrates, inasmuch as the papers on vertebrate embryology have been brought together, within the last few years, in well-known treatises on the subject. The first volume treats of the Sponges, Cnidaria, Ctenophora, Platyhelminthes, Nemertines, Nemathelminthes, Annelids, Echinoderms, and a few smaller groups. In the second volume the authors promise to treat of the Arthropods, Molluscs, Molluscoids, Tunicates, and Amphioxus; and the book will close with a general part.

The substance of the first volume is largely made up of reviews of the most important papers published since Balfour's time, and, so far as we can judge, these are admirably presented, and are noticeable for clearness as well as conciseness of statement. The authors believe fully in the evidence of embryology to solve most of the problems of phylogeny. They hold fast to the gastrula ancestry of the Metazoa, and each larval form is marshaled up to tell its tale of how the groups arose. This diagrammatic conception certainly admits of clearness of treatment; but whether it represents the high-water mark of morphological speculation may be open to doubt.

[12] *Zool. Jahrbuch*, Abth. Anat. Ont., IV., p. 297, 1890.

[1] Edited by Dr. T. H. Morgan, Johns Hopkins University, Baltimore, Md., to whom books and pamphlets for review should be sent.

Each of the sections ends with a general part, in which the authors bring together the essential points of the papers on the subject, and give their interpretation of the meaning of the facts.

The first section, on the Sponges, is admirable, and a much better-balanced presentation than that given by Balfour, who has unduly emphasized the amphiblastula larva. They believe the Sponge is a distinct phylum, only connected with the other Metazoa in its earliest history,—"nur an seiner Wurzel." The group has a true blastula and gastrula stage, but believing the polyp to represent the ancestral Cœlenterate, they do not think the Sponges have any affinity with the latter group. For the Cœlenterates they adhere to the old views that the fixed Hydroid represents the ancestral form, and the Medusæ a higher, more specialized, and later form; and they reject the free-swimming jelly-fish as an ancestral form, as held by Claus, Brooks, and Vogt. The authors are inclined to believe in the gastrula as the ancestral form of the Cnidaria, and think a secondary change has come into the ontogeny "because the typical larval form of the Cnidaria is the planula. It is probable that the transition of the free-swimming, gastrula-like ancestor was changed into the fixed polyp form through a creeping stage, which the creeping planulæ of many forms now repeat in their ontogeny."

The Ctenophors have many general points of agreement with other Cœlenterates, but recent work (Hertwig, Lang, Hatschek) goes to show that the Ctenophors have had an independent origin. They show no evidence of a polyp ancestry in the ontogeny, and the formation of organs shows they have no close relationship to the Medusæ. To sum it all up, the Ctenophors represent an independent phylum of the animal kingdom, and only at the base unite with the Cnidaria.

The Turbellarians show many common characteristics in segmentation and gastrulation with the Ctenophors, but if these two groups came from the same root, each has become so changed that only general resemblances are possible.

The Trematodes go back to Turbellarian-like flatworms which have assumed a parasitic life. The Nemertines, although more highly developed, are probably related to the flatworms, and it is not possible to separate Nemertines from the Turbellarians in order to place them among the segmented worms. Hubrecht's hypothesis as to the relationship between Vertebrates and Nemertines can have only an entirely speculative value. The embryology of the Nemathelminthes throws no light upon their ancestry, and we cannot determine whether they are related to the Nemertines on the one hand, or to the Annelids on

the other. The Rotifers go back to the Trochophora, and Semper's Trochosphæra shows this relationship.

The Annelids include Chætopods, Echiuriden, Dinophilus, Myzostoma, Hirudinea, Branchiobdella.

The treatment of the group is interesting, and brings out clearly the tendency of the authors to overestimate, as I believe, the value of embryology as affording a solution to phylogeny. The Trochophore larva is the typical larval form of the Annelids. It is exceedingly probable that the Trochophore of Annelids is a recapitulated stage of an ancestral form of the group which was common to the Annelids, Mollusca, and Molluscoida, and from which these groups diverged. It is difficult to determine from what ancestors the Trochophore itself arose. The authors give their reasons for rejecting the Medusæ as the ancestors of the Trochophore. They conclude that the facts indicate that the Trochophore developed directly out of a ciliated gastrula-like forefather, and by a change in the method of progression. The transition of the Trochophore-like ancestor into the typical Annelid (Archiannelid) took place by an increase in the length of the body and a diminution of the head. At the same time a change from a free-swimming to a crawling animal took place, and this process is repeated in the ontogeny of living Annelids. The Sipunculids show resemblances to the Annelids, but cannot certainly be referred to that group; and their resemblance to Phoronis and Molluscoids is not sufficiently established. The Chætognatha are perhaps most nearly related to the Annelids.

The Tornaria of Balanoglossus shows certain resemblances to Echinoderm larvæ, but it appears to be only in external and non-essential characters, and the Tornaria comes nearer to the Trochophore. There is some uncertainty as to the relationship of Balanoglossus to the Chordata.

The radial structure of the Echinoderms is due to the ancestral form having been fixed and subsequently become a free-living animal. To what group of the Bilateralia these go back to is "in der Luft." (I cannot believe the authors have fairly treated the apparent relationship, as Metchnikoff has pointed out, between the Echinoderms and Balanoglossus, through perhaps a Holothurian form.) The larva of the Echinoderms, they think, comes nearest to the Trochophore.

Whether or not we agree with these more speculative parts of the volume, the general verdict seems to be that the authors have produced a useful book. An English translation would probably appeal to a larger audience and excite a wider interest in embryology.

Amphioxus.—Prof. E. Ray Lankester and Mr. Arthur Willey have a paper on "The Development of the Atrial Chamber of Amphioxus," in the *Quar. Jour.* for Aug., 1890. Mr. Willey made some observations in Sicily on the life of the adult and the embryo which are of interest. The adults will spawn in glasses, and this takes place about an hour after sundown. The eggs must be distributed into glasses containing clean, unfiltered water from the pantano in which the adults live. "If the water is filtered, or if sea-water [outside of the pantano] is employed," the eggs "will either die or develop abnormally." Most, if not all, of the ova were discharged through the atriopore, which contradicts the statement of Kowalevsky, who says they issue from the mouth.

The young larva rests habitually on one side, and does not bury itself in the sand. The larva shows for a time the most marked asymmetry, with the mouth on one side and a single row of gill-slits on the other.

The young Amphioxus, after regaining its symmetry, does not lie on its side, "but buries itself upright, tail downwards, with the oral hood alone projecting from the sand." The spawning occurs from April to September, inclusive.

The greater part of the paper is taken up with a description of the formation of the atrium and of the organs in the head region.

The Life-History of the Red Blood-Corpuscles.—Prof. W. H. Howell, of the University of Michigan, has a most important and interesting paper on the origin of the corpuscles of the blood. A rather full abstract of this paper is given below, as the subject is one of great interest to all students and teachers of physiology, and is either treated in a most meagre way, or, worse still, false statements are not infrequent in many of our text-books of physiology. Those who care for a fuller account will find Dr. Howell's paper instructive (*The Journal of Morphology*, Vol. IV., No. 1):

"Before 1869 it was quite generally believed that the red corpuscles are formed from the white corpuscles, most probably while in the circulation," but "the evidence is overwhelming against this view. In the very young embryo two forms of red corpuscles are found,—one large, oval, and always nucleated, resembling the corpuscles of the lower vertebrates; and one small, biconcave, circular in outline, and found both nucleated and non-nucleated. The latter are the true mammalian corpuscles; the former represent possibly ancestral corpuscles. The true mammalian corpuscles lose their nuclei by extrusion.

The nuclei of the nucleated red corpuscles of the *young* embryo (except of the larger variety) are lost while in the circulation. . . . As the embryo grows larger, and the production of new corpuscles becomes localized in different organs,—liver, spleen, marrow,—more and more of the early history of the corpuscles is passed over while still in the blood-forming organ, and more and more of the red corpuscles are sent into the blood in the non-nucleated stage. In the first part of embryonic life new red corpuscles are produced in the liver from groups of mesoblastic cells, outlining the position of future blood-vessels (veins). It is probable that new red corpuscles are formed in all parts of the body where blood-vessels are being developed." This view of the origin is essentially different from that of Klein and Balfour, as given in the "Embryology of the Chick," where it is asserted that the red corpuscles are endogenously *within* large mesoblastic cells. "In the second half of embryonic life red corpuscles are formed in the liver, the spleen, and the marrow of the bones, the function being most active first in the liver, then in the spleen, and, finally, in the red marrow of the bones, where it continues during adult life.

"The white corpuscles and blood-plates do not occur in the circulating blood of young embryos, but make their appearance in later embryonic life." Certain nucleated cells of the red marrow of the bones multiply by division, later loose their nuclei by extrusion, and getting into the blood become the red corpuscles, and the biconcavity of these corpuscles may be due to the extrusion of the nucleus.

The white blood corpuscles are derived from the lymph leucocytes. These enter the circulation, and are at first not amœboid. The nucleus increases in size as the leucocyte grows older; finally it fragments, and probably this is followed by disintegration of the whole cell. The fragments of the nuclei persist for a time as the blood-plates. See Minot in NATURALIST, November, 1890.

Appendages of the First Abdominal Segments of Embryo Insects.—Mr. Wheeler has made a comparative study of the larval appendages of the first abdominal segment of insects (Trans. Wisconsin Acad. Science, etc.) He concludes that the appendage—the pleuropodia—of this segment were at one time organs of considerable functional importance in the primitive Hexapods, but are not equally well represented in the larva of all existing groups. They are serially homologous with the appendages of the thorax and abdomen, and in the embryos of existing insects these rudimentary structures

are found as evaginations or invaginations of thickened ectoderm. Rathke, Ayers, and Graber believe these rudimentary appendages represent embryonic gills. Wheeler objects to this interpretation, as the cells of the pleuropodia are large, swollen, vacuolated structures, and would prevent any great interchange of gases between the blood and the air. Nor could these pleuropodia be sense organs, as Patten and Cholodkovsky believed, for no one has discovered even the trace of a nervous system running into them. The author is led to the belief that the organs must be large ductless glands, which were functional in ancestral insects. It seems probable that the pleuropodia represent appendages homologous with the thoracic legs, and may have been, at a remote time, ambulatory appendages, and subsequently converted into functional glands in the ancestors immediately preceding living insects.

Are the Arthropods the Ancestors of the Vertebrates?—Two papers of a speculative nature have appeared side by side in a recent number (Aug., 1890) of the *Quarterly Journal of Microscopical Science.* The contrast between these cannot be without its value. Dr. William Patten, of the University of North Dakota, Grand Forks, U. S. A., makes the first attempt to establish "the origin of vertebrates from Arachnids." The other production comes from Cambridge, England, and is advanced by W. H. Gaskell, M.D., F.R.S., to establish "the origin of vertebrates from a Crustacean-like ancestor." It is difficult to bring one's self into the proper mental condition to treat these matters seriously; but that the authors, especially Gaskell, are in dead earnest there can be no doubt.

Patten seems to have been led to his hypothesis in studying the anatomy and embryology of Scorpions and Limulus; while Gaskell, if we remember aright, was started towards his present goal by the resemblance between *tumors* in the spinal cord and in the digestive tract.

A detailed review of these papers is impossible here, and the barest outline must suffice. Briefly, then, Patten inverts a Limulus, or a scorpion, or anything similar, and proceeds to compare the principal organs of his up-side-down beast with a vertebrate right-side-up, proving the identity of the structures! The most important comparison is between the nervous systems of the two groups. The three brain vesicles of the vertebrate find their homologue in the supraœsophageal and fused thoracic ganglia of the scorpion. The cranial nerves of the vertebrate are the results of the first *thirteen* neuromeres of the Arach-

nid. (The fatal number *thirteen* seems unfortunate just at present—see Dohrn!) Then follows a lengthy comparison between the vagus of the vertebrate and a series of nerves from the posterior part of the thoracic cord, and a comparison between the eyes of the two groups. The cranial flexure of vertebrates is entirely explained in the relationship of the supraœsophageal ganglion (fore- and mid-brain) of the scorpion to the thoracic ganglia. The notochord finds its homologue in the "median furrow" of Arthropods, which comes from the *ectoderm*, and the support of this homology is found forthwith in our ignorance of the origin of the vertebrate cord! "Only a strong faith in enteric diverticula, and in the red, white and blue gastrules of embryological treatises, can lead one to the belief in the entodermic origin of the notochord. On the other hand, its growth at both ends from superficial cells, and the manner in which it is frequently wedged in between the nerve cords, indicate its ectodermic origin." This is an excellent example of the author's scientific state of mind in treating so important a question as the origin of the vertebrates!

The gill-slits come from the rudimentary nephridia of the thorax, and somehow—it doesn't matter much, since they must—connect secondarily with the digestive tract.

The fossil fish Pterichthys probably shows the transitional form between Limulus and the vertebrates. The mouth of the latter group is a new affair, coming from a dorsal sucking organ of our ancestors, and our other Limulus-mouth has long since disappeared.

Our views of gastrula and blastopore must be rejected, and newer ideas received, which will show a wonderful similarity between Arachnids and vertebrates.

Gaskell, in a former paper, demonstrated how the nervous system is composed of nervous material grouped around a central tube, which tube was originally the alimentary canal of an invertebrate. The present paper shows, he thinks, that the lowest vertebrate nervous system (Ammocœtes) confirms his theory. The old invertebrate digestive tract is now the central canal of the nerve cord. Of course the vertebrate now turns over, and a new digestive tract arose from the *gill region* of the Crustacean (how the author includes Limulus in this process is not yet clear to us, for Limulus he includes in his Crustacea). Nor does the author, yet a while, explain how a new mouth arose; perhaps he has not finally settled on a convenient Arthropod organ. The ventricles of the vertebrate brain and the canalis centralis of the cord is the invertebrate ancestor's digestive tract, and the infundibulum of Ammocœtes is the old œsophagus and mouth.

The pineal eye of the vertebrate may be reduced back to the three-layered Arthropod type. There is another more rudimentary pineal eye which belongs to the left side, while the previous one connects with the right ganglion habenulæ. The brain of Ammocœtes almost compels us to recognize the supracœsphageal ganglion of the Crustacean, etc.

If any one hopes to find a grain of truth in either of these two contradictory theories, which exhibit wonderful displays of mental gymnastics, starting from the Arthropods as from a spring-board, thence to take their aërial flight, let such a person read them side by side.

ENTOMOLOGY.[1]

A Review of Some Plum Curculio Literature.—A few years hence, when it is finally and definitely settled whether the Plum Curculio (*Conotrachelus nenuphar*) can be successfully fought on a commercial scale by spraying with the arsenites, there will be an opportunity to write a most curious and instructive chapter in the annals of economic entomology. This question has been under discussion by entomologists for more than twenty years, and to judge from the latest publications concerning it, the end is yet in the distant future. Nearly all our economic entomologists have taken part in the discussion, and the final record will show a curious mixture of assent and dissent on the part of those concerned.

Before attempting a brief analysis of this record, I desire to quote from a letter recently published in *Agricultural Science* (Vol. IV., p. 97), in which I made the following statements concerning the philosophy of spraying with the arsenites, and the conditions necessary for a fair test: "The remedy undoubtedly acts mainly by destroying the adult beetles that feed upon the poisoned surface of the fruit and foliage, thus preventing, to a greater or less extent, the deposition of the eggs. It need not necessarily act at all upon the beetles when engaged in oviposition, nor upon the larvæ after hatching. Consequently a fair test cannot be carried on with a half dozen trees close together, three of which are sprayed and the others not. Beetles from the unsprayed trees may oviposit in the fruit of those sprayed, and the beetles killed on the sprayed trees will lessen the injury to their checks. For the same reason a fair test cannot be carried on in an orchard in

[1] Edited by Dr. C. M. Weed, Experiment Station, Columbus, Ohio.

which every alternate tree is sprayed. A conclusive experiment necessitates an orchard of considerable size,—one half to be sprayed and the other half either to be jarred or left untreated,—or else two orchards near together, with a similar difference in treatment. Of course, by the every-other-tree method, results of some value may be obtained, but the conditions of the commercial orchard, where all the trees are sprayed, are far from being reached."

So far as entomologists are concerned, the discussion of this subject appears to have begun in 1870, when Dr. C. V. Riley wrote the following paragraph upon it :[2]

"Mr. G. M. Smith, of Berlin, Wisconsin, . . . recommends Paris green for the Plum Curculio. Even if the uniform application of such a poisonous drug on large trees were practicable, it would never succeed in killing one Curculio in a hundred. Paris green kills the leaf-eating beetles by being taken internally with the leaves; but the Curculio, with its snout, prefers to gouge under the skin of the fruit, and only exceptionally devours the leaves. Yet, notwithstanding the palpable absurdity of the remedy, it has very generally passed from one journal to another without comment."

Fifteen years later Dr. Riley delivered an address before the Mississippi Valley Horticultural Society, in which, "in giving his experience as to the feeding habits of the beetles, he urged experimentation with the arsenites in this direction as promising fair results, though in the very nature of the case not as satisfactory as in the case of the Codling Moth."[3]

In November, 1888, Dr. Riley, in reviewing a bulletin by Professor A. J. Cook, in which the latter reports successful results with the arsenites as Curculio destroyers, wrote :[4]

"We have long felt that they [the arsenites] might be used with benefit for this purpose, but from the nature of the case we have anticipated less good than in the case of the apple worm, and Professor Forbes's experiments, and some unpublished experiments which we have had made by Mr. Alwood, confirm this view."

Shortly after this Dr. Riley read an elaborate paper concerning the Plum Curculio before the American Pomological Society, at its meeting in February, 1889, in which the use of arsenical sprays was especially discussed. This article, in substantially the same form, was also incorporated in the memoir upon the Plum Curculio published by Riley

[2] Third Report State Entomologist Missouri, p. 18.

[3] Riley. Rept. Am. Pom. Soc., 1889, p. 31.

[4] *Insect Life*, November, 1888, Vol. I., p. 123.

and Howard in the Report of the U. S. Department of Agriculture for 1888. In this article the author summarized the experiments of Alwood, Cook, Osborn, Forbes, and Weed, and made the following concluding statement: [5]

"On the whole, the remedy is one which is a desirable addition to our list, although it will never become so great a success as the application of these poisons for the Codling Moth, and for two reasons: (1) The egg is deposited, and the beetle gnaws, preferably upon the smooth cheek of the fruit, where the poison does not so readily adhere, and from which it is more easily washed off; (2) the larva, eating directly from the flap, does not come in contact with the poison, as does the larva of the Codling Moth."

In the Department Report article already referred to Riley and Howard state that "there can be no doubt but [that] practical use has demonstrated that the jarring method is the most effective way yet proposed for destroying these insects." [6]

I have already called attention [7] to the fallacy of the arguments contained in the next to the last of these paragraphs; but as the periodical in which my letter was published seems not to be generally circulated among entomologists, and as there was also a printer's blunder which misrepresented my remarks, they may be quoted in this connection. Referring to the reasons given for the assertion that spraying for the Curculio "will never become as great a success" as in the case of the Codling Moth, I said: "The fallacy of these arguments lies in the assumption that the *modus operandi* of the method is the same for both insects,—an assumption that obviously is not justified by facts. In the case of the Codling Moth, the remedy acts by destroying *the larva after it has hatched from the egg*, while with the Curculio it acts by destroying *the beetle before the eggs are laid*. This throws the arguments concerning the place of oviposition and the food habits of the larva entirely out of court, leaving only that expressed in the phrase, 'The beetle gnaws preferably upon the smooth skin of the fruit, where the poison does not so readily adhere [as in the calyx of the apple?], and from which it is more easily washed off.' To what extent this is true, and what importance should be attached to it under the circumstances, are openquestions. The green fruit of many, at least of the so-called foreign plums, is covered with a fine pubescence, in which particles of London purple or Paris green readily lodge, and are not easily blown or washed away.

[5] Rept. Am. Pom. Soc., 1889, p. 34.

[6] Report U. S. Department Agriculture, 1888, p. 68.

[7] *Agricultural Science*, Vol. IV., p. 98.

"Clearly, if the question of comparative efficiency raised in the paragraph quoted above is to rest on a rational basis, it must be put in something like the following form: Is the deposition of Curculio eggs prevented (through the destruction of the parent beetles) by the application of arsenites to plum trees in as great a proportion as Codling Moth larvæ are destroyed by the same applications to apple trees? It is probable that each female Codling Moth and Plum Curculio deposits on an average about fifty eggs, so that, reduced to figures, this question resolves itself into the following: Is the application of the arsenites as likely to kill one adult female Curculio, feeding indiscriminately over a large amount of poisoned surface, before it has deposited eggs, as it is to kill fifty Codling Moth larvæ before they enter the apples.

"In order to get at field conditions, suppose that in an orchard of 1,000 apple trees there was a female Codling Moth to each tree, and that in an orchard of 1,000 plum trees there was a female Curculio to each tree. It is usually estimated that seventy-five per cent. of the fruit liable to injury by the Codling Moth is saved by spraying; so it becomes a question of whether spraying will be as likely to destroy the equivalent of 750 female Curculios before their eggs are laid, as it will to destroy 3,750 Codling Moth larvæ after they hatch. The answer to this question will be found along the experimental rather than the *a priori* road."

It will readily be granted, from the explanation already given, that if the case be restricted to a single tree, or a few trees in the midst of other trees liable to injury by the Curculio, the odds would be in favor the Codling Moth, at least for the first brood, but on a commercial scale the above reasoning must apply.

The writings of Professor A. J. Cook form an important part of the discussion upon this subject. During the first six or seven years of the last decade he frequently expressed the opinion that the Curculio could not be destroyed by the arsenites. For instance, in 1886 he is on record as saying:

"Paris green, kerosene emulsion, and other poisons are of no avail against the Curculio. He will not eat them."[8]

In 1887 Professor Cook took up the subject in an experimental way. The only record of the season's work is the following paragraph:[9]

"Paris green, in the proportion of one tablespoonful to six gallons of water, was very thoroughly sprayed upon four plum trees, May 18th. The petals had all fallen, but the dried calyces still clung to the fruit. On August 20th the trees were visited, when it was found that the two

[8] Report Mich. Board of Agriculture, 1886, p. 141.

[9] Report Mich. State Board of Agriculture, 1887, p. 40.

treated trees of the Wild Goose variety had dropped all their fruit, as had the untreated trees of the same kind. Another treated tree of a yellow variety was loaded with plums, of which only fifteen per cent. were stung, and those not badly. The fourth tree treated was a purple variety, and had not less than seventy-five per cent. of its fruit badly stung."

Professor Cook wisely refrains from drawing any conclusions from an experiment of such doubtful value. It is extremely probable that the Curculio had nothing to do with the dropping of the fruit on the Wild Goose trees, as this variety nearly always drops its fruit just after it sets, on account of the lack of fertilization of the ovule. The two remaining trees about offset each other, one having seventy-five per cent. of wormy fruit, and the other eighty-five per cent. of sound plums. The trees were sprayed but once, and a period of more than three months apparently elapsed during which no observations were made upon them.

In 1888 Professor Cook repeated the experiment, apparently on a slightly larger scale. An unrecorded number of cherry trees and three plum trees were sprayed with London purple, one pound to 100 gallons of water, June 6th, 12th, and 20th. The sprayed fruit of both kinds matured with little or no Curculio injury, while "cherry and apple trees near by not sprayed suffered seriously." The author gives the following conclusions :[10]

"From these experiments, and those of former years, I conclude that while one application will not save our plums and cherries, and prevent apples from being stung, two or three applications may be of signal advantage."

The experiments were repeated in 1889 "with no success. All the trees were severely attacked and all the plums lost." Nothing is said concerning cherries. Professor Cook thinks he is "warranted in the following conclusions :"[11]

"The arsenites will protect against the Plum Curculio if they can be kept on the tree or fruit. But in case of frequent rains the jarring method will not only be cheaper but much more effective."

Finally, in 1890 Professor Cook issued as Bulletin No. 66 of the Michigan Agricultural College, an article entitled "Fighting the Plum Curculio," in which spraying is entirely repudiated, and "the old reliable method" of jarring is fallen back upon as "the surest, cheapest, and best method to banish the Curculio and save our plums." As before, no details of experiments justifying such an entomological

[10] Bull. No. 39, Mich. Agr. College, p. 9.

[11] Proc. Tenth Meeting Soc. Prom. Agr. Science, 1889, p. 28.

stepping backward are vouchsafed, the entire record being embraced in the following paragraph:

"Trees were very thoroughly sprayed, at intervals of ten days, as many as five times, and after each rain, and yet in several cases every plum was stung and fell off. Some small trees, heavily loaded, were sprayed, and though no rain came to remove the poison, yet in less than a week all the plums were stung by the Curculio. Both last year and this, with the exception of one tree, nearly all the plums were stung. These fell from the tree, were all gatherd up and cut open, that we might be sure that the grubs were present."

This record is remarkable for the absence of any indication of details from which one might get an idea of the fairness of the experiment. We do not know the number, size, position or variety of the trees sprayed; nor whether they were surrounded by unsprayed trees; nor the dates of spraying; nor the amount of rainfall; nor the poison used; nor the proportion of poison and water; nor the method of spraying; nor whether the work was done under the author's personal supervision, or by untrained and inexperienced assistants. The present writer has learned from conversation with Professor Cook that ten trees only were included in the test.

These Michigan experiments for several years past, which are being quoted far and wide, are all open to the following objections:

(1) They have not been carried on with a proper understanding of the theory upon which the remedy rests. As a consequence, the every-other-tree method, or the method of a few trees treated among many untreated, has been employed,—methods by which no results of value to the commercial grower can be obtained.

(2) They have been conducted, so far at least as the record indicates, on too small a scale.

(3) The records of the experiments are incomplete and unsatisfactory. Nearly all of the details essential to a full knowledge of the force of the experiments are omitted.

Professor Herbert Osborn, in 1888, made some experiments on the grounds of the Iowa Agricultural College, which have been quoted by Riley and Howard in the Plum Curculio article already referred to. A few trees of native varieties were sprayed twice, among others not sprayed. Only a small proportion of the plums were injured in either case, and the experiment showed a small percentage in favor of the sprayed trees. But there were two insects engaged in the work,—the Curculio and the Plum Gouger (*Coccotorus prunicida*),—and the injuries of each were not separated. Careful observations made in the

same region, and presumably in the same orchard, the next year, by Mr. C. P. Gillette, showed that ten times as much injury was done by the Gouger as by the Curculio. Consequently, so far as the Curculio is concerned, this experiment might well have been left out of the record.

In 1889 Mr. C. P. Gillette made some careful experiments on native varieties of plums at the Iowa Experiment Station, apparently on the same orchard that Professor Osborn had worked in the year before. Mr. Gillette recognized the dangers of the every-other-tree method, making a distinct statement of the principles involved, in the Bulletin of the Iowa Experiment Station for May, 1890 (pp. 383–384), shortly after the publication of my letter in *Agricultural Science*, which, however, he had probably not seen when his article was written. The percentage of Curculio injury on both sprayed and unsprayed trees was extremely small, though "the indicated saving of fruit that would have been injured in the absence of treatment was forty-four per cent." In this experiment only two sprayings were made, and, as the author states, both were too early to take most effect upon the Curculio.

The conclusions concerning the Curculio reached by Professor Forbes, in his admirable experiments in spraying apples for the Codling Moth, have frequently been quoted to show that the benefit to be derived from spraying for the insect is much less than in the case of the Codling Moth. But, aside from the fact that in these experiments the injuries of the Apple Curculio (*Anthonomus quadrigibbus*) and the Plum Curculio are not separated,—which alone would vitiate the conclusions so far as they relate to the latter insect,—a few trees were sprayed in the midst of others untreated, so that, from the principle already stated, results of little value, so far as the Plum Curculio is concerned, could be expected.

In 1887 Mr. W. B. Alwood made some experiments on the grounds of the Ohio Experiment Station, on the strength of which he has frequently claimed priority in demonstrating the usefulness of the arsenites as Curculio destroyers. No record of them was published until 1889, when they were incorporated in Dr. Riley's American Pomological Society article, and also in the Riley-Howard memoir in the Department of Agriculture Report for 1888 (pp. 70–71). Three plum trees of the Green Gage variety were treated in the midst of about twenty-five untreated trees of four other varieties. One Green Gage was left as a check. Paris green, at the rate of one pound to fifty gallons of water, was applied May 13th and 17th. Of course two such strong applications, only four days apart, greatly injured the foliage, so that "fully fifty per cent. fell off." Mr. Alwood continues:

"The trees were set very full of fruit, and much of this withered and fell. However, fully one-half of a crop was matured. There was one other tree in the orchard of this variety, and it matured more fruit than the other varieties, but not one-half as much as those which had been so thoroughly treated with the poison. This tree was set in spring as full as they were. It seems possible from this note that the gages are not so much injured by the Curculio as the other varieties. However, this is not at all certain."

It is needless to state that this part of Mr. Alwood's experiment proved nothing. He also sprayed some cherry trees, treating one row with Paris green once, and another with kerosene emulsion once. This experiment was even more fruitless than that on the plum, and was abandoned before final results were obtained. Some experiments of decided value, however, were made by Mr. Alwood upon feeding poisoned fruit and foliage to Curculios in confinement, which will be referred to later.

My own experiments upon this subject began in 1888, when seventy-five Early Richmond cherry trees, occupying a half-acre block, were chosen for this work. The west half of the orchard was sprayed, and the east half left as a check. London purple was applied three times, in the proportion of eight ounces to fifty gallons of water. At time of ripening, eight sprayed trees and seven check trees were selected, and 1,000 cherries from each were critically examined for Curculio injuries. It was found that 14.5 per cent. of the unsprayed fruit gave evidence of Curculio attack, while 3.5 per cent. of the sprayed fruit was injured. There was consequently a percentage of benefit of 75.8. The same year similar experiments were made upon plums and pears, but as stated in the record[12] the opportunities for a satisfactory test were not so good as with the cherries, so that, although the fruit was saved, less stress was laid upon the results.

In 1889 the cherry experiment was duplicated, the parts of the orchard being reversed to eliminate any possible effect upon the results that might be due to the situation. In 1888 the west half was sprayed, and the east half left as a check; in 1889 the east half was sprayed, and the west left as a check. London purple was applied three times, in the proportion of one pound to 160 gallons of water. At time of ripening, 1,000 cherries were picked from each of twenty-four trees in each half of the orchard—a total of 48,000 cherries—and examined for Curculio injuries. The percentage of injury on the untreated trees was 6.17, while on the treated trees it was 1.5. This gives a percentage

[12] Seventh Annual Rept. Ohio Agr. Exp. Station, pp. 134–150.

of benefit of 75.6,—just .2 per cent less than in 1888. Plums sprayed with a combination of London purple and the Bordeaux mixture matured a full crop, while unsprayed trees a few rods distant lost all their fruit. The record of this year's work will be found in the Bulletin of the Ohio Agricultural Experiment Station for September, 1889 (Vol. II., pp. 133–143).

While these experiments were made as complete and satisfactory as the circumstances would permit, and every essential detail was inserted in the records, they were open to three objections, namely: First, that while the remedy might work in a region like Central Ohio, where fruit-growing forms only a small proportion of the agricultural interests of the inhabitants, and where the Curculio, though abundant, is not so overwhelmingly present as in a region almost exclusively devoted to fruit production, it might be impracticable in the latter region; second, that the plum orchard was not sufficiently large to make a test under the conditions of the commercial orchardist; and third, that the cherries upon which some of these experiments were conducted ripened before the season of egg deposition of the Curculio was over. The force of these objections was fully appreciated while the experiments were in progress, but the work was done in the belief that results of value could be so obtained, and with the expectation of giving the method a thorough trial, from the standpoint of the commercial orchardist, if the preliminary tests were sufficiently encouraging.

The present season a plum orchard of 900 bearing trees in Ottawa county, Ohio, right in the heart of a great fruit-growing region, was selected for the experiment. In the north half of it the method of catching the Curculios by jarring on a sort of inverted umbrella mounted on wheels was employed, while the south half was sprayed four times with pure Paris green mixed with water, in the proportion of four ounces to fifty gallons.

The first application was made May 8th, just after the blossoms had fallen from the late-blooming varieties. There was a heavy rain the same night, and it rained almost continuously until May 15th, when there was a short cessation. The second spraying was done on that day. The third spraying was made May 26th, and the fourth and last, June 2d.

On the jarred portion of the orchard a great many Curculios were caught, showing that they were present in numbers. A careful examination of both parts of the orchard was made on June 3d. Between one and two per cent. of the fruit on the sprayed trees had been stung, while about three per cent. of the plums on the jarred trees were injured. No damage to the trees was then perceptible.

Early in July the orchard was again examined. Some of the sprayed trees showed that the foliage had been damaged by the spraying, but the injury was not very serious. Not over three per cent. of sprayed fruit was stung at that time, while about four per cent. of that on the jarred trees were injured. But on both the fruit was so thick that artificial thinning was necessary to prevent overbearing.

A large crop of fruit was ripened on both parts of the orchard, and so far as could be judged from one field experiment, it showed that spraying is as effective as jarring.[13]

Professor Cook, referring to this experiment, has asked: "Would the crop have been a failure had he not sprayed? And, if so, will he get equal results every season?"[14] To the first question I can only answer that in the jarred half of the orchard large numbers of Curculios were obtained,—enough to ruin the crop had they not been caught. It is fair to presume that they were equally abundant in the sprayed half. The second question is easily answered. If the crop would have been a failure without spraying, obviously the spraying saved it. And if the success was due to spraying alone—a condition involved by the query itself—future experience must conform to that of the past. I do not say that this is all demonstrated, but simply answer the question with the premise involved in it. Professor Cook continues: "Occasionally we secure a crop, with no effort to fight the Curculio. Does not this suggest an explanation why some who have given this remedy a limited trial speak so highly of it." If the "*limited* trial" refers to the Ohio experiments, which have been carried on for three successive seasons, and in which an aggregate of 1,200 fruit trees have been employed, I would venture to inquire what constitutes an *extended* trial? There is certainly nothing in the record of the Michigan experiments to indicate that half this number of trees have been employed.

I had intended briefly to summarize the records concerning the feeding habits of the Curculio, and the laboratory experiments in poisoning it, but the limits of space forbids so doing. Suffice it to say, that Dr. Riley in his earliest articles showed conclusively that the adult beetles feed freely upon the fruit and foliage, and that the subsequent observations of Forbes, Comstock, Cook, Gillette, Osborn, Alwood, and others abundantly confirm his account; while the feeding of poisoned fruit and foliage to beetles in confinement by

[13] This experiment is recorded in Bulletin Ohio Agr. Experiment Station, Vol. III., pp. 225–228; September, 1890.

[14] Bulletin No. 66, Mich. Agr. College, p. 6.

Forbes, Cook, and Alwood have rendered it certain, to use the words of the first-named experimenter, that "there can be no further question of the liability of the Curculio to poisoning by very moderate amounts of either London purple or Paris green while feeding on the leaves and fruit of peach and plum." [15]

It is sincerely to be hoped that future experiments upon this subject will be conducted with a proper understanding of the *rationale* of the method, and on a sufficiently extended scale to give results of value to the commercial orchardist. The experience of another season has strengthened my conviction of the force of the following statement (written nearly a year ago, and published in the *Agricultural Science* letter already referred to), with which this review may well be ended: "It seems to me that the evidence now in hand is sufficient to point to the conclusion that spraying with the arsenites is a complete and practical remedy for the Plum Curculio, at least in good-sized orchards of cherries, plums, and apples; and that the experiment stations can best serve horticulture by encouraging the practice among commercial orchardists, and carefully recording the results obtained, so that they may be collated in the future, and a definite conclusion be reached. If the simple process of spraying is effective, it is useless to complicate matters by advising jarring in wet seasons, planting plum trees in apple orchards, or various other modifications of the treatment that have been suggested."—CLARENCE M. WEED.

ARCHÆOLOGY AND ETHNOLOGY.

The Societe d'Anthropologie at Paris.—*A Sketch of Its Organization and Work.*—The year 1859 was one memorable in the science of anthropology. In this year was published Darwin's work on the "Origin of Species." Whatever may be the truth of the theory announced by him, whatever degree of opposition it may have received, its appearance in the world marked an era in science.

In 1859 was also discovered, or rather was acknowledged as true, the discovery by Monsieur Boucher de Perthes of the paleolithic implements in the gravels of the river Somme. He had made this discovery originally in the year 1836, and had published as a result thereof several brochures, but they were not generally accepted or received in the scientific world until 1859.

[15] Forbes. *Insect Life*, Vol. II., p. 7; July, 1889.

I cannot do better than to quote from some of those who were his contemporaries and assisted in that discovery a short sketch thereof.

In the year 1859, or rather in November of 1858, was organized the Societe d'Anthropologie at Paris. It did not get into working order until the beginning of the year 1859. There were six members at the first reunion; when it was completed and perfected there were nineteen. M. Philip Salmon, in his article on the Societe d'Anthropologie in the Dictonaire d'Anthropologie, gives their names: MM. Anthelme, Beclard, Bertillon, Broca, Brown-Sequard, de Castelneau, Dareste, Delasiauve, Fleury, Follin, Isidore-Geoffroy Saint-Hilaire, Godard, Gratiolet, Grimaux-de-Caux, Lemercier, Martin-Magron, Rambaud, Robin, Verneuil. They commenced their work much the same as our own society, and with much the same success. In 1862 they numbered 102 paying members. This society passed through much the same stages of growth as has our own. It limited its active members to its own neighborhood,—the city of Paris,—and made certain distinctions between active and associate members. In the year 1863 they did what we have just done,—abolished such distinctions,—and it was in that year that the society entered upon the successful course which has marked its history to the present time. Broca early conceived the idea of the establishment of a laboratory of anthropology in connection with the society. He had already organized such a laboratory, which was installed in the ancient church of the Cordeliers, in which was installed the Musèe Dupuytren. He had brilliant hopes for this society, and desired to attach to it a series of public scientific lectures. This he called the Ecole d'Anthropologie. Of this I will speak further on. There was such success in this establishment that the Societe d'Anthropologie transferred itself from the Faculty of Medicine, where it was first installed, to the Musèe Dupuytren, 15 Rue de l'Ecole de la Medicine, where it is now established. This change was made in the year 1876, and here were established the three organizations, the Society of Anthropology, the School of Anthropology, and the Laboratory of Anthropology, to which is now to be added, by reason of the legacy of Broca, the collection of his lifetime relating to anthropology, and called the Musèe Broca. These organizations were principally the work of Broca. He was the head and front, the organizer, the manager, the director; yet he never held any higher office than that of secretary. It was his hope, and afterwards his pride, to see these organizations established and united, and it was a part of his pleasure to call them the Institut d'Anthropologie. Broca died the 9th of July, 1880, after the society had been organized twenty-one years. He was

universally regretted, and the society of which he was secretary received various testimonies from the anthropological societies of the world. Broca probably did more than any other man of his time to advance the science of anthropology. It was his life's labor. He was a profound student, an indefatigable worker, a close and accurate observer, reported his conditions with great detail, and was thoroughly enamored of his science. He had that aptitude for the management of men, for the harmonizing of those annoying differences of opinion which are sometimes unfortunately made public by scientific men. Broca harmonized these inharmonious elements, and was recognized as a friend of all parties. He was entitled to and received their confidence. If his influence in this regard was great, his wisdom and good sense were greater. The society determined to erect a monument to his memory. The funds were furnished by public subscription, and the monument was installed the 29th of July, 1887, and now stands at the triangle between the Boulevard St. Germain and the Rue de l'Ecole de la Medicine, in front of the Faculty of Medicine. It is of bronze, is of life size, and stands on a granite pedestal about ten or twelve feet from the ground. It represents the great master holding in his left hand a human skull, and in the other the instruments of anthropometric measurement.

It is only fair to the Senate of France to say that it recognized the claims of science to a share of the government; that it recognized the important part played by scientific men in elevating France to the high position which she has occupied among nations. In accordance with this idea, and having confidence in the great good sense and wisdom of Broca, they elected him a senator for life. He continued in this office, and performed its duties, without neglecting the demands of his science, until the day of his death. Not only was this appointment a proper recognition of science, but it was a compliment to Broca directly, and incidentally to the Societe d'Anthropologie,—one which its members and anthropologists generally in France always remember with pride.

The Societe d'Anthropologie early determined upon a practical course to make known to the world, in a permanent form, the results of the investigations of its members in the new science. This was by the publication, first of bulletins, and afterwards of memoirs. The bulletins were commenced on the 19th of May, 1859, and have continued until the present time. The memoirs commenced soon after, and have also continued until the present time. Both are published quarterly. The bulletins are divided into three series: the first is six

volumes from 1859 to 1865, the second is twelve volumes from 1866 to 1877, the third is eleven volumes from 1877 to 1888. They comprise about 500 or 600 pages per volume, and are for sale for the price of $2.00 a volume.

The members of the society who pay their yearly dues, consisting of thirty francs, or $6.00, are entitled to receive the bulletins without further payment. The memoirs are published much the same as are the bulletins. The members are not entitled to them except on payment. They are divided into two series as are the bulletins. They average from 500 to 600 pages per volume, and are sold at sixteen francs each.

The *Revue d'Anthropologie* was published by Broca during his lifetime. He was succeeded by Dr. Topinard. But it has ceased as the *Revue*, and has been consolidated with the *Materiaux* and the *Revue d'Ethnographie*, and will have for its three editors, Topinard, Cartailhac, and Hamy.

The Musèe Broca contains all the objects gathered by Broca during his lifetime bearing upon the science of anthropology. It is installed in one of the rooms of the society. It possesses several hundred skeletons and about five thousand skulls. These belong to every country, and include those of every epoch from the prehistoric to the modern, and likewise every race of people.

The Societe d'Anthropologie also possesses a considerable library. It receives and exchanges with other societies and organizations, purchases, etc., the various books, and now numbers in its catalogue about 7,000 volumes relating to anthropology and its kindred sciences.

Prizes Offered by Various Members of the Society.—Dr. Godard was one of the original organizers of the Societe d'Anthropologie. He died in 1862. He provided by will for a prize of the value of 500 francs, to be given each two years to the author of the best memoir on the subject belonging to anthropology, and left the decision and management thereof to the society. Regulations were adopted governing the competition. Any one could compete except the members of the central committee. The jury of examination was to be composed of five members, who were to be elected four months in advance. The manuscript should belong to the society, and in case no prize was awarded at any competition, the sum should be added to the next.

In 1881, one year after the death of Broca, his widow founded another prize of 1,500 francs, to recompense the author of the best memoir on human anatomy, or that branch of physiology which

related to anthropology. The rules governing this are much the same as those of the Godard prize.

In 1883 Monsieur Adolphe Bertillon, called Bertillon père to recognize him from his distinguished sons, also instituted a prize, which should be given for the best memoir concerning anthropology, and notably for demography. This prize was a value of 500 francs, and is given under much the same rules as the foregoing.

These prizes are all distributed under the direction of the society, and the days of competition are made gala days.

Laboratory of Anthropology.—After the establishment of the Society of Anthropology, which served as a common ground on which the various scientists could meet, read papers, argue, discuss, and elaborate and make known their theories, it was found that the needs of this great science required a laboratory or workshop, in which experiments could be instituted and methods practiced necessary for proper scientific investigations. Broca was the first to discover this, and he instituted such a one in his private apartment and for his own use; but it soon outgrew its environment. In 1876 he procured quarters in the Convent of the Cordeliers, which he maintained at his private expense. In 1868 Broca was gratified by receiving the recognition of his laboratory as one of those belonging to the École des Hautes Études. The state from that moment paid a portion of the expense, and gave small subsidies to Broca by which he was enabled to carry on his work. This was continued until the year 1876, when the School of Anthropology and the Laboratory were recognized by the government as a public utility, and received a place in the governmental budget.

Broca directed the laboratory until his death. His various assistants were MM. le Docteurs Topinard, Manouvrier. At his death, Mathias Duval was appointed as director.

The laboratory is organized so as to carry on the study of craniometry, anthropometry, comparative anatomy of the human race, and the primates. It has its halls for dissection, making casts or moulds for drawings and for study. Dr. Manouvrier is at present, and has been for several years, the principal officer in charge. There are also to be seen here, and used, the instruments of anthropometry which were largely invented by Broca, and also a collection of all the French and European instruments for a like purpose.

The extent to which this laboratory is employed shows in the number of students and the amount of work performed, which can be approximately understood by a list that might be given at great length, but a summary only can be here made.

The students who have occupied the laboratory, and profited by its existence to follow their various branches in the science of anthropology, aggregated from 1881 to 1888 a total of 293. This does not include the visitors nor those who did sporadic work, but only those who devoted themselves seriously to the study of some branch of anthropology. The following gentlemen have performed work in the laboratory and library, more as professors than as students, the principal results of which have been recorded in memoirs, some of which have been read before the society, and all have been published in the scientific journals, principally in those related to the Societe d'Anthropologie, to wit: the bulletins, memoirs, and *Revue*. The best of such published memoirs are as follows:

Broca (died in 1880), 8; Mathias Duval, 90; Manouvrier, 59; Topinard, 41; Chudzinski, 39; G. Hervè, 22; Deniker, 19; Goldstein, 7; Mahoudeau and Zuborowski, each 5; Kuff, Tenkate, Mereschowski, Bordier, and Mondeires, each 3; Blanchard, Real, Toroch, and Fère, each 2. The following gentlemen each produeed one: Drs. Dally, Rey, Renard Calmette, Ujfalvy, Pasteau, Bouvier, MM. Girarde, Rialle, Golstein, Drs. Weisgerber, Ducatte, Ribe, Debleme, Marcano, Bajenoff, Felix Regnault, Orchansky, Baron d'Hercourt, Danillo, Carriere, Neis, Chambellan, and Cauvin; making a total of 345 memoirs, theses, or notes, published as aforesaid.

M. Chudzinski is one of the most successful artists in Europe for the reproduction in plaster of objects belonging to anthropology. He has made, and they are now to be seen in the museum, 157 pieces of this work.

It would not be practicable to give any complete list of the publications of these gentlemen in connection with the Laboratory of Anthropology. I may, as a sample, and because he is a personal friend, give a list of the publications of Dr. Manouvrier, together with the journal of publication.

1. Measurements and Record of 1,500 Skulls from the Catacombs of Paris. In the *Public Register* of the Laboratory of Anthropology, 1880.
2. On the Cubic Index of the Skull. Association Française, Rheims, 1880.
3. Comparative Study of the Skull and the Skeleton. Congrès d'Algier, 1881.
4. Weight of the Skull. Bull. Soc. d'Anthropologie, 1881.
5. Craniology. *Revue Scientific*, 1881.
6. Torsion of the Humerus. *Revue d'Anthropologie*, 1881.
7. The Fuegians. Bull. Soc. d'Anthropologie, 7 Nov., 1881.

8. Weight of the Brain. Acad. des Sciences, 6 Jan., 1882.

9. Height and Weight of Body and Brain. Ibid., 2 Feb., 1882.

10. The Brain and the Skeleton. Soc. Zool., 1882.

11. Force of Muscles and Weight of Brain. Ibid., August, 1882.

12. Grand Regions of the Skull in the Two Sexes. Ibid., 1882.

13. Relation between Intelligence and Weight of Brain. *Revue Scientific*, June, 1882.

14. The Galibis. Bull. Soc. Anthrop., Oct., 1882.

15. Skulls of Some Assassins. Ibid., Feb., 1883.

16. Plagiocephaly. Ibid., June, 1883.

17. The Weight of the Cerebellum and the Bulb. Congrès de Rouen, 1883.

18. The Skull in Its Relation to Age and Height. Ibid.

19. The Cingalese and the Araucams. Bull. Soc. Anthrop., 1883.

20. The Relations between Domestic Animals. Bull. Soc. Zool., 1883.

21. Dynamometric Errors. Bull. Soc. Anthrop., 1884.

22. A Comparative Study of the Sexes. Progress Française, Jan. 6th, 1884.

23. The Function of the Psycho-Motor. *Rev. Philosoph.*, 1884.

24. The Profile of the Brain Compared with the Cavity of the Skull. Bull. Soc. Anthrop., Bordeaux, 1884.

25. Ethnology and Ethnography. *l'Homme*, March 25th, 1884.

26. Vitrified Fort of Puy de Gaudy. Bull. Soc. Anthrop., 1884.

27. Three Cases of Congenital Idiocy. Congrès Blois, 1884.

28. Idiots and Imbeciles of Hospital Blois. Ibid.

29. Character of the Skull and the Brain. Second paper. Interpretation of the Weight of the Brain, Memoirs Soc. d'Anthrop, 1885.

30. The Indian Tribe of Omahas. Bull. Soc. Anthrop., 1885.

31. Graphic Display of Anthropological Series. *l'Homme*, Feb., 1885.

32. Prehistoric Trepanations. Bull. Soc. Anthrop., 1885.

33. Physio-Pyschologic Dynamometry. Soc. Biology, 1885.

34. Prehistoric Skulls of Grenoble. Conggren Grenoble, 1885.

35. The Skeleton of Members of Man and of the Anthropoid. Ibid.

36. Dolichocephaly. Soc. Anthrop., Lyons, 1885.

37. Capacity of the Skull of Sixty Assassins. 1885.

38. Skull of an Imbecile. Bull. Soc. Anthrop., 1885.

39. New Variety of the Wormian Bones. Ibid., 1886.

40. Five Skulls of Senegambiens. Ibid.

41. Craniology of Three Lunatics. Ibid.

42. Consecutive Movements of Mental Images. *Rev. Philos.*, 1886.
43. Skulls of Executed Criminals. Archives of Anthrop., Criminal, 1886.
44. Importance of Craniology. 1886.
45. The Greek Profile. Congrès of Nancy, 1886.
46. A Micro-Cephalic Idiot. Bull. Soc. Anthrop., 1887.
47. Seance of Spiritism. *l'Homme*, 1887.
48. Neolithic Skull of Crecy-en-Brie. Bull. Soc. Anthrop., 1887.
49. The Brain of M. Bertillon. Ibid., 1887.
50. Prognathism and Its Measure. Congrès of Toulouse, 1887.
51. Platycnemy. Memoirs Soc. Anthrop., 1887.
52. Cerebral Comparisons. *Rev. Phil.*, 1887.
53. Vitrified Forts, Walls, and Tumuli, 1887.
54. Studies of a Rickity Dwarf. Congrès of Oran, 1888.
55. The Temporal Convolution of a Deaf Person. Bull. Soc. Anthrop., 1888.
56. The Flattening of the Sous-trochanter. Ibid.
57. Frontal Circonvolutions, *à masse du Corps.* Ibid.
58. Heights of the Parisians. Ibid.

School of Anthropology.—As I have already said, the School ot Anthropology, like the society and laboratory, was indebted to Broca for its establishment. From almost the beginning of his labors in behalf of this science, Broca was of the opinion that the people should be educated in it. He believed that, in addition to all other opportunities, there should be provided that which is so popular in France,—courses of lectures for the public. In 1870 he obtained from the Dean of the Faculty of Medicine permission to deliver a course of lectures on anthropology in the public hall of the chemical school. In connection therewith he carried on clinical conferences in the laboratory in the Musèe Dupuytren. This course was confined to a single lecturer, himself, and was far from realizing his hopes as desired in this direction. He had organized in his imagination the Institute of Anthropology, which combined the three,—the society, the laboratory, and the school; and that there should be a number of chairs and professorships to teach the principal branches of the science of anthropology. Broca expressed himself very clearly and at length upon this subject, and as his saying has the same application to the present time as when uttered, and to our country and our society as to France and the Parisian society, I am justified in quoting it:

"In a project for the reorganization of the Faculty of Sciences of Paris, presented to the National Assembly, Prof. Paul Bert proposed to

institute at the Sorbonne a chair of anthropology. This thought is excellent, and I hope that it will sooner or later be realized. It is still possible that other chairs of the same nature will be established at the College of France and in certain faculties of the provinces. But no matter how many of such single or isolated chairs of anthropology we may have, they will never respond to the needs of education. Good to instruct and to interest the public auditor, and consequently of great utility, they will never serve the needs of the student. If the course is to be accomplished in one or two years, it will be superficial. If it should last for five or six years, like that at the museum, it can be complete and excellent; but then it will be necessary for students to consecrate to the study of anthropology more time than for law or for medicine. Anthropology is not yet a profession, it does not lead to any public or scientific career, it has no hopes for the future; it will be rare to find scholars or students who are sufficiently impressed with this science to persevere to the end. They must also be rich in money, that they may maintain so long an initiation. It is necessary to form a school of anthropology where each of the principal branches can have a chair and a professor, to the end that the entire science can be taught each year in a simultaneous course, by men specially trained therefor."

This was a vast programme, and presented enormous difficulties, but they did not daunt Broca. His indomitable will, seconded by his ardent love for his science, caused him to push his endeavors until he arrived at a happy result. If it was necessary to obtain authorization from the government, he obtained it; subscribers, he gathered them; money, he found it. Carried away by his convictions, he took as founders around him Bertillon, Chudzinski, Collineau, Mortillet, Topinard, Manouvrier, Hamy, etc. The government of France, the Department of the Seine, and the city of Paris combined to furnish each a part of the money needed for the establishment of this School of Anthropology. A generous scientist, Dr. Jourdanet, himself provided the expense of one of these chairs.

On the 30th of October, 1876, everything was completed, and the ministerial authorization received, The 15th of November following, the course of lectures and teaching commenced. Broca's pride was satisfied when he said, upon that occasion, "the foundation of a School of Anthropology at Paris enables us to state with pride that anthropology is a science altogether French."

Other countries might have established chairs of anthropology and aught it in their educational establishments before this, but this was

the first successful attempt to establish a course of anthropology, with numerous lecturers and professors who should coöperate and endeavor to teach the entire science in a single series.

Broca, as director, charged himself with the course of anatomic anthropology, and delivered two lectures per week. Dr. Dally was professor of ethnology, Hovelacque of language, G. de Mortillet of prehistoric anthropology, and Dr. Topinard of biologic anthropology. In 1877–'78 Monsieur Bertillon took charge of the course of demography; in 1878–'79 Monsieur Bordier commenced a course of medical geography, which chair had been established and paid for by Dr. Jourdanet.

On the death of Broca, the 9th of July, 1880, Monsieur Mathias Duval was designated to succeed him in the chair of anatomic anthropology; and Monsieur Gavarret, a professor of the Faculty of Medicine and Inspector-General of Superior Education, was denominated director of the school.

At the death of M. Bertillon, the 28th of February, 1883, the chair of demography was suppressed. In 1884–'85 Monsieur Dally was taken sick, and Dr. Manouvrier supplied his place; and the same year MM. Blanchard and Hervè were designated to make supplementary courses.

In 1885–'86 the chair of the history of civilizations was created, and Dr. Letourneau was designated as professor. The 1st of January, 1888, Monsieur Dally being dead, Monsieurs Hervè and Manouvrier were called respectively to the chairs of zoologic anthropology and physiologic anthropology, and Monsieur Lefevre was charged to supplement Monsieur Hovelacque. Finally, in 1889, supplementary courses were added, of which MM. Chudzinski, Mahoudeau, and Adrien de Mortillet had charge.

The programme of the lectures for the year 1888–'89 will give an idea of the scope of the science of anthropology as thus taught. It is as follows:

Anthropogeny and Comparative Embryology—The Fecundation of the Egg; The Laws of Heredity. Prof. Mathias Duval.

Zoologic Anthropology—The Anatomy of Man Compared with the Vertebrates; The Members. Prof. M. Georges Hervè.

Anthropology General—Parallel between the Characters of Superiority and Inferiority of the Human; Genealogy of those Characters in the Animal Kingdom. Prof. Dr. Topinard.

Prehistoric Anthropology—Origin of Hunting, Fishing, and Agriculture. Monsieur Gabriel de Mortillet.

Physiologic Anthropology—The Evolution of Psychology; Parallel between the General Doctrines of Metaphysics and the Doctrines of Science. Prof. Dr. Manouvrier.

History of Civilizations—The Evolutions of Political Institutions in the Different Races of Human Kind,—Government, War, Justice. Prof. Dr. Letourneau.

Medical Geography—Comparative Pathology; Parasitic Maladies; These Among the Different Races. Prof. Dr. Bordier.

Ethnography and Language—Their Relations to Mythology. Prof. M. Hovelacque, with M. Andre Lefevre as assistant.

The supplementary course for the same year was:

The Cerebral Convolution. M. Chudzinski.

The Principal Phases of the Evolution of the Brain. M. Mahoudeau.

Paris and its Environs in Prehistoric Times. M. Adrien de Mortillet.

The programme of lectures before the School of Anthropology for the current year 1889–'90 is as follows:

Prehistoric Anthropology—The Origin, Development, and Constitution of the French People; Autochtones; Ligurians and Iberians; Celts or Gaulois; Bergundians and Franks; Divers Elements. Prof. Gabriel de Mortillet; Monday and Wednesday, 4 o'clock.

Anthropogeny and Comparative Embryology—The Blastoderm of the Vertebrates, and the Theory of the Gastrula. Prof. Dr. Mathias Duval; Monday, 5 o'clock.

Ethnography and Language—The Myths and Gods of the Atmosphere, of the Stars, and of the Heavens, from the Times of Antiquity Until the Present. Prof. Andre Lefevre; Tuesday, 4 o'clock.

Zoologic Anthropology—Anatomy of Man Compared with that of the Vertebrates; The Members (continuation). Prof. Georges Hervè; Tuesday, 5 o'clock.

Medical Geography—Action of the Environments; Transformism (Evolution); Effect of Climate on Man and upon Organized Beings. Prof. Dr. A. Bordier; Friday, 4 o'clock.

Physiologic Anthropology—Human Anatomy in Its Relation to Psychology. Prof. Dr. L. Manouvrier; Friday, 5 o'clock.

History of Civilization—The Evolution of Jurisprudence in the Different Human Races. Prof. Dr. C. Letourneau; Saturday, 4 o'clock.

Comparative Ethnography—The Industry of Modern Savages Compared with that of the Prehistoric People. Prof. Adrien de Mortillet; Saturday, 5 o'clock.

Histologic Anthropology—Histology of the Nervous System and Its Principal Relation with other Systems of Organism. Prof. Dr. P. G. Mahoudeau; Wednesday, 5 o'clock.

Anatomic Demonstrations—Done at the Musée and Laboratory. Prof. Chudzinski; Saturday, 3 o'clock.

The card on which the foregoing announcements are made has this note at the foot:

"A register for inscription is at the school for the auditors of the course who may desire a certificate of attendance."

Because of my greater interest in that branch of anthropology belonging to the prehistoric, the course of lectures which were given by Monsieur G. de Mortillet attracted me most. I give the divisions of his course during the two or three later years.

The Origin of Man: Man during the Tertiary Geologic Period.—A glance at the history of the theories of the origin of the earth and of man; geology, general notions; geologic revolutions and their causes; continued movements of the surfaces; theory of earthquakes; laws of paleontology; succession of living (or created) beings; precursor of man, fossil monkeys; indication of the existence of an intelligent being during the Tertiary period; incised bones from Mount Operto, Italy; depot of Thenay (Loir and Cher), flints, burnt or retouched; depot of Puy-Courny (Cantal), split flints, fauna; depot of Otta (Portugal), flints chipped, fauna and flora; human skull of Calaveras, California; skeletons of Brescia, Italy; jaw of Moulin-Quignon; subdivisions and climatology of the Quaternary period; Neanderthal skull and race; skulls of Engis (Belgium), of Olmo (Italy), Laugerie-Basse and Cro Magnon (Dordogne); transformation and filiation of man; date (approximate) of the appearance of man; chronometers; glaciers, a proof of the antiquity of man.

Origin of the Arts, Agriculture, and Industry.—Heat, fire, lighting; beaux arts—engraving, sculpture, painting, music, architecture; medicine, surgery, sculpture, and religion; arms—hatchets, *casse-tetes*, swords and poignards, bows and arrows, defensive arms; instruments—knives, scrapers, razors, saws, etc., etc.; hunting, fishing, navigation; agriculture, horticulture, domestication; dress and ornaments; metallurgy—gold and copper, bronze and tin, iron, silver, and lead; ceramics—pottery, glass, enamel.

This has lasted two years in the course, and will be published as a separate volume.

Some of these lectures were illustrated by means of lantern slides. Those of Prehistoric Anthropology and Archæology were as follows:

Silex tertiare otta	65
Cromlechs munergces	54
Roche Montonnees	14
Glaciers de forna	6
Portraits (P. Broca and others)	7
Quarternaire stratigraphie	48
Archæologic (bronze)	83
Paleothologic (stone)	91
Megalethiqus (dolmen)	19
Ethnographic (char.)	30
	417

In addition to the courses of lectures, which have now been continued for fourteen years past, and of which the foregoing are given as an example, there have been other lectures, either delivered by special lecturers or upon special subjects under the direction of the Society of Anthropology:

Eulogy of Dr. Paul Broca, by Monsieur Dally, 1884.

The Distinctive Characters of the Human Brain, by Monsieur Pozzi, 1885.

A Study of the Races of Mankind in the Lower Valley of the Nile, by Monsieur Hamy, 1886.

Aphasy Since the Time of Broca, by Monsieur Mathias Duval, 1887.

The Nervous Centers, by Monsieur Laborde, 1888.

(*To be continued.*)

MICROSCOPY.[1]

Medullated Nerve-Fibres.[2]—Prof. Kultschitzky offers the following methods designed to take the place of Weigert's hæmatoxylin method. Kultschitzky's method permits of washing the preparation after fixation, and so avoids, to a great extent, the precipitation of chromic salts in the tissues.

The material must lie in Erlicki's fluid 1–2 months, then be washed in water 1–2 days, and hardened in alcohol. Then follows imbed-

[1] Edited by C. O. Whitman, Clark University, Worcester, Mass.

[2] Kultschitzky. *Anat. Anz.*, September 12, 1890, No. 18, p. 519.

ding in celloidin, and sectioning with the microtome in the usual way. The sections thus obtained are stained in

ACID HÆMATOXYLIN.

Hæmatoxylin, 1 g., dissolved in a *small quantity* of absolute alcohol, added to acetic acid (two per cent.) 100 g.

One to three hours in the stain is generally sufficient. After staining, the sections are to be placed in a

LITHIUM SOLUTION.[3]

Lithium carbon. (saturated solution) . . . . . 100 ccm.
Ferricyanide of potassium (one per cent. solution) . 10 ccm.

In this solution the sections generally remain from 2-3 hours. The time required for decoloration may be reduced by adding more ferricyanide of potassium. After decoloring, the sections are to be well washed in water, passed through alcohol, and mounted in balsam in the usual way.

Instead of the above hæmatoxylin solution, we may use with equal success

ACID CARMINE.

Carmine . . . . . 2 g.
Acetic acid (10 per cent.) . . . . . 100 ccm.

The powdered carmine is heated 2–4 hours in the acid, and the solution, after cooling, is then filtered. The time for staining is 24 hours. Decoloration is effected in the same manner as before. The process, however, is more rapid than with hæmatoxylin, and hence it must be closely watched.

Henneguy's Methods with Pelagic Fish-Eggs.[4]—The eggs may be killed in water strongly acidulated with acetic acid. In the course of a few minutes the embryo becomes quite distinct, and the eggs are then transferred to chromic acid, one per cent. At the end of three days they are placed in water, and the chorion removed. After 24 hours in water, they are placed in ninety per cent. alcohol, then in absolute alcohol. Such preparations are excellent for surface views, but difficult to section on account of the hardness of the yolk.

The isolation of the germ from the yolk may be accomplished in two ways:

1. The egg is placed in osmic acid, one per cent., for a few minutes, until it has acquired a light brown color, then transferred to Müller's fluid, and the chorion cut open with sharp scissors. In this fluid

[3] Dr. J. Schaffer (*Anat. Anz.*, V., 22, November 21, 1890, p. 643) employed Weigert's borax-ferricyanide of potassium in place of this lithion solution, and with perfect success.

[4] *Journ. d'Anat. et de Physiol.*, 1888, pp. 416-7.

the yolk dissolves, and the cortical layer with the germ can thus be easily isolated. After several days the preparation is to be carefully washed and passed through several grades of alcohol.

This process does very well for the earlier stages, but not so well for the later ones, as the osmic acid does not penetrate the more advanced embryos sufficiently.

2. The method that proved the best was as follows: The egg is immersed for ten minutes in Kleinenberg's fluid, to which has been added one-tenth its volume of glacial acetic acid; it is then opened in ten per cent. acetic acid, which dissolves the yolk, and thus enables one to isolate the germ. The germ is next placed in Kleinenberg's fluid for several hours, then in alcohol.

Bryozoa.[5]—In studying the process of budding in Pedicellina, Loxosoma, and other Bryozoa, Dr. Oswald Seeliger made use of corrosive sublimate (saturated solution in hot sea-water), usually in combination with one-fiftieth its volume of glacial acetic acid. This mixture was used cold, and allowed to act from five to eight minutes. The preparation was thoroughly washed and stained with borax-carmine. To this sublimate-acetic acid mixture was sometimes added chromic acid (one-tenth per cent.), with the result that the epithelial structure was well preserved but difficult to stain.

Caryokinesis in Paramæcium.[6]—In the study of Paramæcium Prof. R. Hertwig made use of picro-acetic acid, chromic acid, and chrom-osmic acid as hardening reagents. Picro-acetic acid followed by borax-carmine was the principal method. The staining process was aided by the heat of an incubator, and decoloration was effected by alcohol acidulated with hydrochloric acid. The preparation was mounted in glycerine or in clove oil. Clove oil is preferable to balsam, as it reveals more clearly the fibrous structure of the spindle, and allows of turning and pressing the object at any time.

Clove oil causes the cytoplasm to become brittle, so that the body of the infusorian may be broken up by pressure or blows on the cover-glass, and thus the nuclear spindles be set completely free. In this isolated condition they can be studied to the best advantage, as they are not obscured by overlying cytoplasm.

For the study of the achromatic figures clove oil is too strong a clarifying medium. Glycerine or water will serve better. Hertwig examined the preparation first in clove oil, then isolated the nuclear figures, washed in alcohol, and mounted in glycerine. He was thus able to study all parts of the figures under most favorable conditions.

[5] *Zeitschrift f. wiss. Zoologie*, XLIX., 1, 1889, pp. 168–9; and L., 4, 1890, p. 561.

[6] R. Hertwig. Conjugation d. Infusorien. Abhl. d. k. bayer. Akad. d. Wiss., II. Cl., XVII. Bd., I. Abth., 1889, pp. 4–5.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

Biological Society of Washington, D. C.—November 29, 1890.—Dr. T. H. Bean read a paper upon "The Death of Salmon after Spawning." He called attention to the fact that the species of salmon upon the northwest coast belongs to a different genus from the salmon on the Atlantic coast, and one of the distinguishing features of the former was the dying of the fish after spawning. In the smallest species, known as the "little humpback," the mortality is excessive, for every individual seems to die after spawning. It is a very abundant and widely spread species. It ascends the smaller streams and deposits its spawn, often a rod or less, or even within ten feet, of salt water, and yet it does not live to reach it again. The reason for this is unknown, but the fact is of great practical importance, for if the species spawns but once in its lifetime, if it is not to become extinct the mouths of the streams must be kept free from obstructions. This is not the case, so that if the fish cannot spawn naturally, it remains only for the Fish Commission to take the matter in charge, and rear the fish artificially.

In the largest species on the coast, when the individuals ascend the streams only about 75 miles, some return to the ocean; but when, as is sometimes the case, they penetrate 500, 1,000, and even 1,500 miles inland, the evidence all goes to show that none ever return to the ocean alive. With the silver salmon a large proportion return to the sea, because they spawn in the small and unobstructed streams, and they are not especially pugnacious. With the dog salmon the mortality is also said to be very great, nearly all dying after spawning.

In the discussion of this paper numerous interesting facts were brought out. Dr. Gill referred to a species of fish which might be termed an annual fish, inasmuch as it matures in a single year, and the young hatched from the spawn at the end of the season are all that remain to continue the species. He also alluded to the peculiar elongation of the upper jaw of the salmon which took place when the fish entered fresh water, and suggested it might be this structural change that caused the mortality.

Dr. Merriam referred to a large specimen of red salmon caught by one of his party on one of the tributaries of the Columbia River, a thousand miles from the ocean, that was four feet long and two feet in girth.

Dr. Theobald Smith spoke of "Species among Bacteria." He stated it to be possible to separate and study the various forms in a nutrient fluid. The species or forms can be separated by both morphological and biological characters. Among the former were enumerated form, size, formation of spores, method of germination, flagella, and staining. The biological characters are the results of culture, both in liquid and upon solid media. The forms can be distinguished by habitat, by the formation of ferments which liquify gelatine, by fermentation, by affinity for oxygen, by coloring matter, and by their occurrence in disease.

As examples of these differences the bacillus of anthrax and of hay were compared. They were long supposed to be closely related, and under the microscope both look alike, both grow in the same way, and both have spores of the same kind. But when the two are cultivated in a liquid the hay bacillus will form a scum upon the top of the liquid in a short time; the liquid will then become cloudy throughout, and finally clear up. With the anthrax, on the contrary, the cloud makes its appearance at the bottom of the culture tube. In germination of the spores, the anthrax grows in the direction of the larger diameter, while the other grows at right angles to it. If the hay bacillus be placed under the skin of an animal, it is innocuous. But if the anthrax be injected, it will kill in twenty-four hours.

Again, in the typhoid fever and the hog cholera bacillus there is great similarity in morphological characters; but when cultivated they assume different colors. In the fermentation tube hog-cholera germ evolve gases, while the typhoid do not. One form of the comma bacillus cultivated on gelatine liquifies it; another similar form does not.

In the discussion Mr. True thought the morphological characters were those which characterized higher groups than species; they were rather family, perhaps ordinal, characters. Dr. Smith, in replying to this, stated that it was impossible to say what were family, what were generic, what were ordinal characters, but those he had mentioned were of use in distinguishing the various forms one from another.

[In the course of the discussion the fact that the organisms under consideration were of vegetable rather than animal nature was lost sight of. While, therefore, the morphological characters of form, size, spores, etc., referred to would not do to separate species of animals, they are exactly the characters used by botanists to separate species of plants. Dr. Smith, therefore, in stating that species could be separated

upon the morphological characters of form, size, etc., gave characters which are of *specific* value in plants, though they may not be so in animals.—J. F. J.]

Geological Society of America.—Second annual meeting, Washington, D. C., Dec. 29, 30, and 31, 1890.—The following papers were read: On the Geology of Quebec and its Environs; Henry M. Ami. Antiquities from under Tuolumne Table Mountain, California; On the Early Cretaceous of California and Oregon; The Structure of a Portion of the Sierra Nevada of California; George F. Becker. The Nickel and Copper Deposits of Sudbury District, Canada; Robert Bell. The Chazy Formation in the Champlain Valley; Ezra Brainerd. Remarks on a Fallen Forest and Peat Layer Underlying Aqueous Deposits at Naaman's Creek, Del.; Hilborne T. Cresson. Mineral and Chemical Composition of Certain Igneous Rocks from the Mesozoic Area in Culpepper County, Virginia; H. D. Campbell and W. G. Brown. A Proposed System of Chronologic Cartography on a Physiographic Basis; T. C. Chamberlin. An Account of the Geology of the Washington Region; On a Jointed Earth-Auger for Geological Exploration in Soft Deposits; Nelson H. Darton. The Geological Date of the Origin of Certain Topographic Forms on the Atlantic Slope of the Eastern United States; W. M. Davis. Two Fossil-Bearing Belts in the Triassic Formation of Connecticut; W. M. Davis and S. W. Loper. Illustrations of the Structure of Glacial Sand-Plains; W. M. Davis and H. L. Rich. Note on the Geological Structure of the Selkirk Range, in the Vicinity of the Line of the Canadian Pacific Railway; George M. Dawson. Note on the Carboniferous Flora of Newfoundland; Sir William Dawson. The Triassic Sandstones in Massachusetts; B. K. Emerson. Glacial Grooves South of the Terminal Moraine; F. Max Foshay and Richard R. Hice. The Overthrust Faults of the Southern Appalachians; C. Willard Hayes. The Quatenary Formations of the Southwest; E. W. Hilgard. On the Probable Upper Jurassic and Basal Cretaceous Beds of the Texas-Arkansas Region, Coastward of the Present Paleozoic Areas, Together with Remarks on Preëxisting Conditions and Subsequent Erosion; R. T. Hill. The Phosphate Deposits of the Island of Navassa, W. I.; E. V. D'Invilliers. The Structure of the Blue Ridge Near Harper's Ferry; Arthur Keith and H. R. Geiger. A Geological Section Across Paris Ridge; The Detailed Stratigraphy of the Carbonic of Central Iowa; Charles R. Keyes. Exhibition of Some New Petrographical Microscopes; A. C. Lane. Notes on Variations in the Tertiary and Cretaceous Strata of Alabama; Daniel W. Langdon, Jr. On Tertiary and Post-Tertiary Changes in Physical Geography on the

Western as Compared with the Eastern Side of the American Continent; A Note on the Mutual Relations of Land Elevation and Ice Accumulation During the Quaternary Period; Joseph LeConte. Geology of the Environs of Quebec; Jules Marcou. The Coal Fields of Alabama; Henry McCalley. The Melting of the Northern Ice Sheet in Northeastern Iowa; W J McGee. Contribution to the Geology of Georgia; P. H. Mell. The Post-Archæan Age of the White Limestones of Sussex County, New Jersey; Frank L. Nason. Relations of Secular Rock Disintegration to Certain Crystalline Schists; Ralph Pumpelly. Glaciers of the St. Elias Region, Alaska; I. C. Russell. On the Geology of Little Falls, New York; N. S. Shaler and H. S. Williams. The Railroads and the Geology Classes in Alabama; Eugene A. Smith. Notes on Two Moraines in the Catskill Mountains, New York; J. C. Smock. Post-Pliocene Continental Subsidence; J. W. Spencer. Geological Notes on Mount Diablo, California; H. W. Turner. Glacial Lakes in Canada; Warren Upham. The Cinnabar and Bozeman Coal Fields of Montana; Walter H. Weed. A Last Word with the Huronians; Alexander Winchell. On the Structure and Petrography of the Piedmont Plateau in Maryland; George H. Williams. Graphic Field Notes for Areal Geology; Bailey Willis. On the Lower Cambrian Age of the Stockbridge Limestone at Rutland, Vermont; J. E. Wolff. Observations Upon the Lava Deposits of the Snake River Valley, Idaho; G. Frederick Wright. (*To be continued.*)

Industrial and Scientific Society of Alabama.—The Alabama Industrial and Scientific Society was organized at the University of Alabama, Thursday, December 11th, 1890, with 70 members. Its objects are the promotion of the industries of the State, and the furtherance of scientific investigations of the problems arising in civil and mining engineering, geology, smelting, and the manufacture of coke. The officers for 1891 are: President, C. Cadle, general manager, Cohaba Coal Mining Co., Biocton. Six vice presidents, viz., Thomas Sedcon, president Sloss Iron and Steel Co., Birmingham; C. P. Williamson, president Williamson Iron Co., Birmingham; W. E. Robertson, city engineer, Anniston; J. W. Burke, president, Tredegar Co., Jacksonville; M. C. Wilson, professor natural science, Normal School, Florence; Col. Horace Harding, U. S. engineer, Tuskaloosa; Treasurer, Henry McCalley, Alabama Geological Survey, University Alabama; Secretary, Wm. B. Phillips, professor Chem. and Met. University Alabama. The annual fee is $5.00. The society will meet three or four times a year at different places in the State for the

reading and discussion of papers, which will afterwards be published. The next meeting will be held in Birmingham, January 28th, 1891.

The American Morphological Society.—A well-attended meeting for the inauguration of an American Morphological Society was held in the Massachusetts Institute of Technology, Boston, on December 29th and 30th, 1890. Officers for the meeting were elected as follows:

President, Professor E. B. Wilson; Secretary and Treasurer, Dr. J. Playfair McMurrich; Executive Committee: Professor E. L. Mark, Dr. C.-S. Minot, and Dr. E. A. Andrews.

After the details of meeting had been completed, the following papers were read and discussed: On the Development of the Scyphomedusæ; J. Playfair McMurrich. On the Intercalation of Vertebræ; G. Baur. The Heliotropism of Hydra: a Study in Natural Selection; E. B. Wilson. The Early Stages of the Development of the Lobster; H. C. Bumpus. Some Characteristics of the Primitive Vertebrate Brain; H. F. Osborn. The Development of Nereis and the Mesoblast Question; E. B. Wilson. The Præoral Organ of Xiphidium; W. H. Wheeler. A Review of the Cretaceous Mammalia; H. F. Osborn. Spermatophores as a Means of Indirect Impregnation; C. O. Whitman. The Phylogeny of the Actinozoa; J. Playfair McMurrich.

The following are the officers of the society for the ensuing year: President, C. O. Whitman; Vice President, Professor E. L. Mark; Secretary and Treasurer, Dr. J. Playfair McMurrich; Executive Committee: The Officers of the Society, Professor E. B. Wilson, and Professor H. F. Osborn.

Third Annual Meeting of the Association of American Anatomists.—Held at Boston, Mass., on December 29th, 30th, and 31st, 1890.—Monday, December 29th.—The Homology of the Cerebro-Spinal Arachnoid with the other Serous Membranes; F. W. Langdon, M.D., Cincinnati, Ohio. Something Additional About the Human Sternum; D. S. Lamb, Washington, D. C. The Merits and Defects of Owen's Account of the Cerebral Fissues; Burt G. Wilder, M.D., Ithaca, N. Y. On the Teeth of Cheiroptera; Harrison Allen, M.D., Philadelphia, Pa. Studies on the Spine; Thomas Dwight, M.D., Boston, Mass. Corrosive Preparations by Different Methods; S. F. Mixter, M.D., Boston, Mass. The Relations of the Olfactory to the Cerebral Portion of the Brain; Burt G. Wilder, Ithaca, N. Y. An Unusual Case of Platycnemy in the Negro; Frank Baker, M.D., Washington, D. C.

Tuesday, December 30th.—Subfrontal Gyri and Problems Connected with the Cerebral Fissures; Burt G. Wilder, M.D., Ithaca, N. Y. A Comparison of the Fibrine Filaments of Blood Lymph in Mammalia and Batrachia, with Methods of Preparation; Simon H. Gage, M.D., Ithaca, N. Y. The Semilunar Bone; Francis J. Shepard, M.D., Montreal, Canada. On the Structure of Protoplasm and Mitosis (Demonstration); Carl Heitzmann, M.D., New York City. A Specimen, George McClellan, M.D., Philadelphia. Corrections of the Article "Gross Anatomy of the Brain," in Wood's Reference Hand-Book of the Medical Sciences; Burt G. Wilder, M.D., Ithaca, N. Y.

The American Ornithologists' Union.—The Eighth Congress of the American Ornithologists' Union was held in the Lecture Hall of the United States National Museum, Washington, D. C., on November 18th, 19th, and 20th, 1890, and was attended by a large number of active and associate members from all parts of the country. The first day's session was devoted to business. Dr. J. A. Allen, of New York, who has been president of the Union since its foundation, declined reëlection, and Mr. D. G. Elliot was elected to succeed him in the presidency. The succeeding days were set apart for the reading of scientific papers, of which the following is a list:

November 19th.—1. The American Ornithologists' Union: A Seven Years' Retrospect; J. A. Allen. An interesting review of the work done in American ornithology since the founding of the Union. 2. Seed-Planting by Birds; Walter B. Barrows. A valuable contribution to economic ornithology based upon the system of stomach examinations now being conducted by the Department of Agriculture. 3. A Study of Bird Waves in the Delaware Valley during the Spring Migration of 1890; Witmer Stone. This paper gave a brief review of the work done by the Delaware Valley Ornithological Club, of Philadelphia, in the investigation of bird migration, and illustrated by a system of charts a new method for the graphic arrangement of migration data. 4. Our Present Knowledge of the Neotropical Avifauna; Frank M. Chapman. An excellent review of the work that has been done on the birds of the western tropics, up to the present time. 5. The Present Status of the Ivory-billed Woodpecker; E. M. Hasbrouck. By carefully-prepared maps Mr. Hasbrouck contrasted the former extensive distribution (nearly throughout the Austro-riparian fauna) of this elegant bird, and its present restricted range in Florida and the southernmost portions of some of the other Gulf States, and showed that in the near future this species will become a thing of the past. 6. Phalaropes at Swampscott, Mass; Wm. A. Jeffries—read by Mr. Chap-

man. 7. The Spring Migration of the Red Phalarope; Harry Gordon White—read by Dr. Allen. This paper gave the results of observations on this bird during a voyage from Massachusetts to the Gulf of St. Lawrence, and indicated that the birds, in the spring of 1890, after following the southern coast of Nova Scotia, passed through the Gut of Canso, instead of rounding Cape Breton Island. 8. Some Observations on the Breeding of *Dendræca vigorsii* at Raleigh, N. C.; C. S. Brinley—read by Mr. Chapman.

November 20th.—9. The Trans-Appalachian Movement of Birds from the Interior to the South Atlantic States, Viewed Chiefly from the Standpoint of Chester Co., S. C.; Leverett M. Loomis. 10. The Birds of Andros Island, Bahamas; John I. Northrop. An interesting account of the birds of this (ornithologically) little-known island, where Mr. Northrop was fortunate enough to discover a fine new species of Icterus (*I. northropi* Allen.) Dr. Allen made some additional remarks upon the birds collected by Mr. Northrop, exhibiting a number of specimens. 11. Some Bird Skeletons from Guadalupe Island; Frederic A. Lucas. 12. On the Tongue of Humming-Birds; F. A. Lucas. 13. Remarks on the Primary Faunal Divisions of North America; C. Hart Merriam. In this able paper Dr. Merriam explained his recently-published Faunal Map of North America, and gave his grounds for abolishing the generally-adopted system of dividing the continent into three great provinces,—Eastern, Central, and Western,—and for deriving the various faunal districts from two primary regions—Boreal and Sonoran. The paper was illustrated by a large series of maps showing all the faunal divisions of the North American continent that have hitherto been proposed by authors.

After this paper, Mr. William Brewster exhibited a number of excellent lantern slides from photographs of wild birds taken in the field.

The following papers were presented, but were not read for lack of time: An Experimental Trial of a New Method for the Study of Bird Migration; Harry Gordon White. The Case of *Colaptes auratus* and *C. cafer;* J. A. Allen. Observations upon the Classification of the United States Accipetres—Based upon a Study of their Osteology; R. W. Shufeldt. Some Notes Concerning the Evening Grosbeak; Amos W. Butler. Owls of Illinois; W. S. Strode. Instinct, Intuition, and Intelligence; C. F. Amery. The Habits of the American Golden Plover in Massachusetts; Geo. H. Mackay. Correction to Revised Catalogue of the Birds of Kansas; N. S. Goss. Second Occurrence of the White-Faced Glossy Ibis in Kansas; N. S. Goss.—W. S.

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